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THE ELECTRIC LIGHTING ACT.

FROM the tone of the remarks made by the President of the Board of Trade last week, when interviewed by the deputation of persons interested in electric lighting, a pretty clear idea may be formed of the extent to which the provisions of the Electric Lighting Act are likely to be modified. It was urged, most strongly by Sir Frederick Bramwell, and less emphatically by other speakers, that the 27th section of the Act should be totally repealed; but Mr. Chamberlain refused to acknowledge that the principle, for which he himself is mainly responsible, is a wrong one, and only admitted that it was perhaps in this case a little too stringently applied. The power of compulsory purchase at the end of a term of years may quite possibly conciliate a local authority and prevail upon it to refrain from taking advantage of the preference it would undoubtedly receive if it desired to undertake the lighting of its own area, and may to that extent be in the interests of the companies, affording them an opportunity of working and earning a profit; but, unless the terms of the concession are such as to give some degree of facility in carrying out operations, and the conditions of the compulsory purchase are so based as to allow of a fair return upon the outlay made during the years of working, it is obvious that, even should an undertaking be entered into, it could not result satisfactorily either to the undertakers or to the community. The conditions of purchase in this case are these: the undertakers are to sell to the local authority "upon terms of paying the then value of all lands, buildings, works, materials and plant of such undertakers," "but without any addition in respect of compulsory purchase, or of goodwill, or of any profits which may or might have been or be made from the undertaking, or of any similar considerations." This may be, at the option of the local authority, within six months after the expiration of twenty-one years from the passing of the Act confirming the Provisional Order, or within six months after the expiration of any subsequent period of seven years—or not at all. Granting the soundness of the principle—there is, at any rate, no prospect whatever of its withdrawal—we may enquire as to whether the time allowed (twenty-one years) is sufficient for the development of an undertaking to an extent that would afford a reasonable remuneration to those who had expended their money in, and given their time and brains to, the working of the concern. The period was originally fixed by the Board of Trade at seven years—we believe merely provisionally—but the strenuous opposition of Sir Frederick Bramwell and others succeeded in procuring an extension to 15 years, and this period was still further extended by the House of Lords to the present term of 21 years. Mr. Hammond admitted last week that, in welcoming the legislation which they believed was to do so much for them, those concerned did not scrutinise the various clauses as closely as they might have done, and, with regard to the point of time, imagined that 21 years might be an adequate period; but the development of events has proved that they were too hasty in their conclusions, and that an extraordinary proportion of that term must pass before the undertaking can be brought into anything like fair working order, so that instead of 21 years in which a profit may be earned, there is left little more than half that period, with the possibility that the undertaking may after all not turn out successfully. In the latter case, of course, the local authority would not step in, but would permit the undertakers to proceed until there was a certainty of remunerative working. No doubt at the time the bill was under discussion, in the comparatively ignorant state of all parties as to the exigencies likely to arise in introducing an entirely new form of enterprise, 21 years seemed at least reasonable; but the last year or so has brought more knowledge on the subject, and we feel sure that, after the representations made to him, Mr. Chamberlain will reconsider this question of time, and bring about still another extension. We have never been amongst those who contended that the Electric Lighting Act was responsible for the whole, or even more than a small portion, of the disaster which has overtaken the greater number of electric lighting companies. Had the Act never come into existence at all, the probability is that all those companies which have passed into liquidation would have been in precisely the same condition ere this, involving, though, a greater amount of loss. Still we are bound to admit that there is that, more important than the question of time, in the 27th section which could scarcely otherwise than exercise a deterrent effect so far as district lighting is concerned. We allude to the terms of purchase by the local authority, which we have stated above. It seems somewhat extraordinary that no compensation whatsoever should be permitted for compulsory purchase or for goodwill; even in the case of tramways, to which Mr. Chamberlain referred as an instance parallel to electric lighting, a price for goodwill is not excluded by the terms of the Tramways Act. In other respects, the section dealing with the compulsory purchase of the tramway is very similar to the 27th Section of the Electric Lighting Act; but, generally, it admits of a much more favourable interpretation than the latter; whilst, also, it is an important point that the local authorities are forbidden to themselves work the tramways, which must be leased, if purchased. Sir Frederick Bramwell, Sir John Lubbock and others, pointed out the enormous differences between a tramway and an electric lighting undertaking to the Select Committee, showing that a tramway was in every way more certain, less dependent on elaborate machinery and delicate instruments, less likely to be superseded and rendered useless by the invention of improved methods, more secure of general adoption,

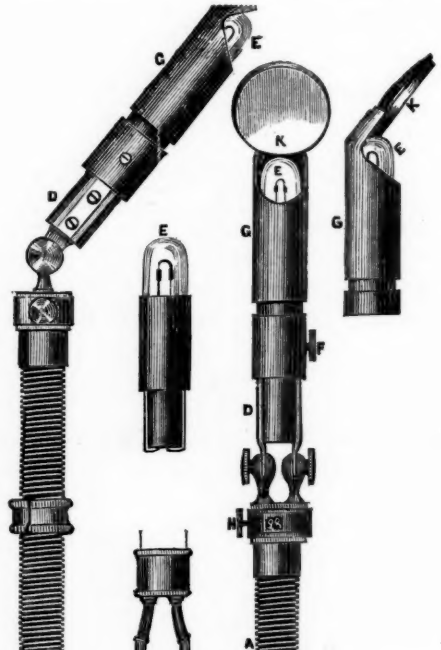
requiring a far less outlay, and providing a convenience far less in the nature of a luxury than the electric light; but to no purpose, for no modification of the clause was obtained. Sir Frederick Bramwell prophesied then that it would not be easy to induce "solvent and trustworthy persons" to embark capital with such a possibility staring them in the face; and last week he repeated that it was impossible to get capital to come into such an undertaking. The deputation asked Mr. Chamberlain for some concession upon this head; and, as he admitted that in regard to details—this, if a detail, is certainly an important one—there was ground for reconsideration, we may fairly anticipate some relaxation of this very stringent stipulation.

Mr. Crompton and Mr. Hammond addressed Mr. Chamberlain with regard to the Provisional Orders, pointing out that the compulsion to lay down mains along every street, or part of a street, specified in Schedule A had been a bar to the carrying out of the Provisional Orders. We should have imagined that this intimation in the Provisional Orders would have sufficiently met the case: "Provided always that the undertakers shall not be compellable to lay down mains in any such street, or part of a street, in case they cannot lay down, maintain, *and work to a reasonable profit*," &c. Then with regard to the questions of compulsory and continuous supply to all consumers, raised by these same gentlemen, it does not seem to us that there is anything so arbitrary in the Provisional Orders; in fact we take it that it is distinctly not intended that the undertakers shall be *compelled* to supply electricity to all within the prescribed area who may demand it, *continuously*. Mr. Chamberlain, too, took this view of the matter, remarking that the obligations of the Orders had been obviously misunderstood. So that, upon these grounds at least, the electric lighting companies have not been in quite such bad case as they have themselves supposed. We cannot doubt, however, that the result of the meeting last week between the President of the Board of Trade and those closely concerned in electric light undertakings will be most beneficial to the industry. In the first place it has led to a fairly clear statement of the views of the Board of Trade upon the claims of the electric light—and these views may be taken as being, on the whole, decidedly favourable—and it has also led to a promise of reconsideration of several of the most onerous requirements of the Act, a promise so phrased as to leave little doubt but that terms more in accordance with the desires of the companies will be conceded.

ELECTRIC MOUTH LAMP AND LARYNGOSCOPE.*

IN diagnosing lesions of the teeth and associated parts the small electric lamp shown in the accompanying engraving will be found an invaluable assistant to the dentist, and by its aid the exact location of the disease may be determined. By the use of the appliances heretofore in vogue this could not be accurately ascertained, and as a consequence many sound teeth have been sacrificed in the fruitless search for the seat of neuralgic pains for which, owing to the insufficiency of the means of diagnosis, no satisfactory cause could be established This lamp illuminates the oral cavity so brilliantly that any departure from normality can be unerringly detected; and as it is placed within the arch, behind the object to be lighted, its rays fall upon the lingual surfaces of the teeth while the eye of the operator is directed to the labial surfaces, and thus every portion of the teeth and gums is thrown into strong relief—the sound teeth appearing translucent and showing no variations in texture, while the unsound teeth have an opaque or dark appearance.

The lamp, E, is an incandescent electric light mounted permanently in a non-conducting case of hard rubber, and provided with metal conductors which pass outside of the smaller section of the case. The lamp is carried in another hard rubber cylinder, D, called the lamp holder, which is also supplied with metal conductors fitting those on the case, the two parts when adjusted being clamped together by the set screw, F, thereby holding the lamp firmly in its socket. The conductors of the lamp holder are connected to the handle, A, by hinged joints, so that almost any desired adjustment can be readily secured. This handle is called a resistance handle because it is wrapped with wire of a low conducting power, by which, through the agency of the ring, I, the flow of current is regulated. When the ring is placed at the end of the handle nearest to the battery cord, the resistance is reduced to the minimum, and the current from the battery flows freely to the lamp.



Sliding the ring to the opposite end of the handle compels the current to travel through the wire with which the handle is wrapped to the ring and back again, thus forming a resistance. The connection to the battery cord, B, is made by the spring coupling, C. A non-conducting shield, G, is placed over the lamp globe for the double purpose of preventing the radiation of heat and of directing the light to any desired point. At H is a screw for breaking the circuit, which should be broken occasionally during a prolonged examination, and, also, whenever the lamp is not in use, to prevent its becoming so hot as to be unbearable in the mouth. In order to admit of the examination of posterior cavities a mirror, set at an angle of 45°, is attached to the end of

* *Scientific American.*

the guard. With this attachment the lamp forms a perfect laryngoscope.

The battery to operate this lamp consists of three improved Bunsen cells having large carbons. The porous cups are filled with the bichromate solution (made in the following proportion : One-half gallon of boiling water, in which is dissolved half a pound of bichromate of potash ; when cold, there are added ten fluid ounces of chemically pure sulphuric acid), and the glass jars with water, to which two ounces of chemically pure sulphuric acid are added. This battery is specially adapted for the work required of it, and produces a strong current of great constancy.

This useful device, which the surgeon and physician, as well as the dentist, will find of great value in the examination of the mouth and throat, is made by The S S White Dental Manufacturing Company, of Philadelphia, Pa.

JOINT FOR ELECTRIC CONDUCTORS.

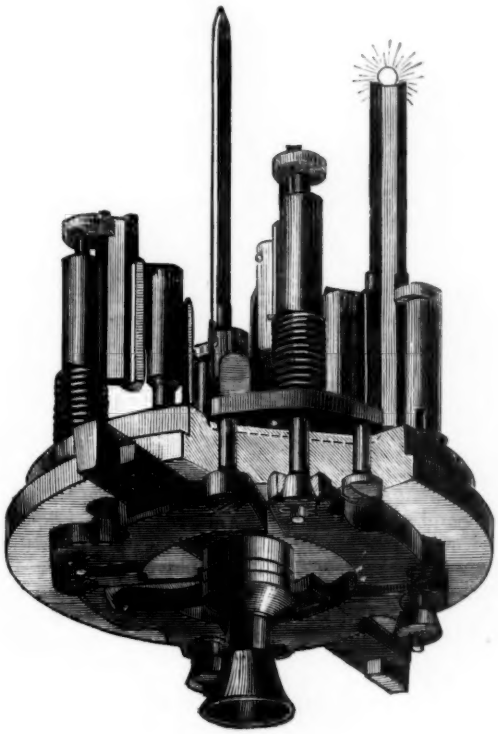
THE annexed engraving shows a joint for electric wires recently patented by Mr. Richard W. Kear, of Pottsville, Pa., and described in an American contemporary. A short tubular socket is provided with a longitudinal slot, diametrically opposite which is a screw threaded aperture containing the binding screw. The ends of the wires are passed into opposite ends of the socket until they

meet below the aperture, when the screw, being turned down, presses and bends the ends of the wires down into the slot, as shown in the upper view, thus holding the ends of the wire in such a way that they cannot be withdrawn. The screw and the tubular socket form an electrical connection between the wires. The manner of using the socket with coated wires will be readily understood from the engraving, but we do not think this device will commend itself to English electricians, at all events for electric lighting purposes.

THE CLARIOT CANDLE-HOLDER.

THE Magazins du Louvre are employing with great success, for the automatic lighting of the Jablochkoff candles, a very simple form of candle-holder, invented by M. Clariot. The apparatus, which is represented in the subjoined figure, consists of a plate of marble, in the centre of which is placed a metallic piece communicating at one side with one of the poles of the generator, and at the other with one of the holders of each pair of candles. The other holder bears a metallic point fixed to a bead of solder ; it is the fusion of this solder which allows the movement of the commutator.

The pairs of candles are four in number ; each pair corresponds to a metallic piece placed on the other side of the plate. These pieces are insulated from each other as long as the metallic point just mentioned rests upon the rod, also metallic, placed in the prolongation of the candle, and opposes the action of the spring



seen in the figure. Under these conditions a single lamp can burn, that one which the central plate puts in communication with the second pole of the machine. When, in consequence of a pair of candles being consumed the solder melts, the spring uncoils and immediately brings the next candles into circuit. This system gives, says *La Lumière Electrique*, very good results.

THE EFFICIENCY OF LIGHTING SYSTEMS.

A GREAT deal has been said and written as to the relative cost of the rival systems of gas and electric lighting by their respective advocates, who are each careful to show in strong relief the merits and advantages of the particular methods. This being so, it may be interesting to take a neutral position and endeavour to ascertain upon what basis each system stands with regard to their relative efficiencies : as this is a point that has been generally neglected, it may be because they are each of them much lower than is generally supposed. As each of the systems begin with the combustion of coal, or of its products, we will take, says the author of a paper communicated to the *Mechanical World*, the example of a ton of coal, and ascertain what result in light may be obtained by the two methods. In the results for incandescent electric lighting we shall employ figures which have been obtained during a long series of experiments by the writer, particulars of the experiments being given as we proceed. From the same source he has also a series of photometric measures of known quantities of gas burnt at ordinary pressures through the classes of burners most commonly in use. The gas measures, however, we shall reject, and accept the values officially given. The reason is that although we are perfectly satisfied with the rejected measures, it may be objected that as they show

little more than one-half the official value there is room for contention if they are used for comparison.

The distillation of one ton of coal will give 9,500 cubic feet of gas, having a nominal illuminating power of 16 candles, besides more or less valuable bye-products, such as tar and coke. This gas burnt through suitable burners will give a light equal to that of a standard candle for 20,400 hours, or to that of 20,400 candles for one hour, which we will call 20,400 candle-hours.

The same weight of coal will give in a good modern engine 1,200-H.P. hours available for driving a dynamo or dynamos. With arc lamps, using Siemens cored carbons, 18 mm. in diameter, with a difference of potential of 42·75 volts, a current of 18 to 25 ampères, and allowing an efficiency of 80 per cent. for the dynamos, we could obtain 5,263,000 candle-hours (*Gordon's Electric Lighting*, p. 107), or 258 times as much as is given by the equivalent gas. We hasten to concede that this is an excessive value for the arc light, and, with the observation that it has undoubtedly been obtained, we will add the average value of a large number of different readings with different carbons and strengths of current taken from the same authority. This gives us 2,825,520 candle-hours, or 138 times as much light. To put the matter in another aspect we may use the 9,500 cubic feet of gas to drive a gas engine, and thus obtain 380 available horse-power hours for driving dynamos. With the best value of the arc this would give 1,578,900 candle-hours, and with the average value 847,656, or 77·4 and 41·5 times as much respectively as could be obtained by using the same gas in suitable burners for direct illumination. As we know very accurately the efficiency of both the gas engine and the dynamo, these figures give us an opportunity of finding the comparative efficiency of gas lighting. The loss arising in the dynamo is already allowed for, the loss in the gas engine is 55 per cent. Taking, then, the best value of arc lighting, we have an efficiency for the gas burner of 0·6 per cent. This result compares very closely with the value determined or approximated on; another method by the late Sir William Siemens, who gave it as "less than one per cent." The comparative efficiency, with the average of several arc lights, is about 1·1 per cent. This value is nothing to be proud of after 60 years' experience with gas lighting, and leaves room for very material improvement. It may be objected that the value we have given to the dynamo (80 per cent.) is excessive, and that such a return was not obtained in the trials referred to. Mr. Sprague's experiments show that in a modern machine the value should be 85 per cent. Experiments with older machines show values from 65 to 80 per cent., and for the particular purpose we are justified in taking a value that could certainly be secured.

Nothwithstanding the high efficiency of the arc light it is unsuitable for general interior illumination, for which the incandescent lamp alone is applicable. Incandescent lamps differ in their efficiency to a remarkable degree. Taking three of the best known types of such lamps, and denoting them by the letters A, B, and C, it was found that the rates of work required to maintain them at their nominal brilliancy were A 4·13, B 2·52, and C 1·81 foot-pounds per second per candle. We have preferred to reduce the rates to the ordinary mechanical units, so as to facilitate comparison and to avoid the use of the unfamiliar electric units. The measures were in each case taken with different groups of 10 lamps each, a large number of each kind being employed in order to obtain a satisfactory average working result, which cannot so well be secured in measuring only one lamp at a time. As the "C" lamps are said by competent authorities to be equal, or about equal, in durability and other respects to the "A" and "B" lamps, we will found our comparison upon them.

According to the figures given, the "C" lamps give 303·8 candles per electrical horse-power, or 243 candles per available horse-power in the engine. The number of horse-power hours available from our ton of coals is 1,120, which gives a total of 272,160 candle hours as against 20,400 from the direct burning of the gas obtained from the same quantity of coals, and against 5,263,000 with the best arc light, or 2,825,520 with average arc lights. Instituting the comparison of the result obtainable by burning the 9,500 cubic feet of gas in a gas-engine, we get 91,140 candle hours for the roundabout method of using the gas against 20,400 for the "direct" method—in other words, we may obtain 4·5 times more light by burning the gas in a gas-engine than is obtainable by burning it in an argand burner, even when using the highly inefficient incandescent lamp. Taking the efficiency of gas as 1 per cent., the efficiency of the "C" incandescent lamp is, according to the figures previously given, 13·3 per cent., which decidedly leaves very ample room for improvement; but, considering that the incandescent system is about three years old and the gas system 60, there appear to be reasonable grounds for the congratulations which have been bestowed upon the pioneers of electricity by their friends.

We have given the relative efficiencies of three types of incandescent lamps, and shown that they vary at their rated powers as 4·13, 2·52, and 1·81. But it is objected by the makers of the A and B lamps that the C lamp is rated too high, while A takes the same objection to B. With the object of putting this matter at rest so far as efficiency was concerned, a large number of experiments were made with groups of 10 lamps each of the three types. Several groups of each type were employed, and members of the groups were continually interchanged, so that no two experiments were made on a group consisting of the same individual lamps. The results were very uniform for each type, and may be taken as a safe practical average. First, each group was supplied with a current capable of yielding one and a half times the rated candle-power; second, with a current giving the rated power; and third, with a current giving half the power. An additional set of experiments were made with the A lamps at double their power in order to meet the suggestion that the A lamps were rated at half the incandescence of the C lamps. The results are given below, the value being in foot-pounds per candle-power:—

		A.	B.	C.
Rated candle-power	× 2·0	3·32	...	...
" "	× 1·5	3·25	1·61	1·4
" "	× 1·0	4·13	2·52	1·81
" "	× 0·5	5·53	4·57	2·76

From these figures it will be seen that the relative efficiencies taken at any reasonable rating are in order of merit C, B, A. That there is not unanimity in the method of rating, the above figures will make evident when it is attempted to formulate a law from them.

The question of rating the lamps involves also the question of durability; but this is essentially a matter of cost, which we purposely exclude, because of its complication, from this article. It may be permitted us to say, nevertheless, that if a lamp is rated at a high power the gas globe soon becomes clouded, and its efficiency thereby diminished; and, further, that its duration is greatly reduced. The element of clouding is one that is generally overlooked by writers on the question, but it certainly deserves attention.

Those of our readers who desire to convert our foot-pound units into volt-ampéres or "Watts" may do so by using the constant 1·355 as a multiplier; this gives for the C lamps at their rated power 2·45 volt-ampères per candle, 304 candles per electrical horse-power, and about 243 candles per horse-power available from the motor as before stated.

The New Telephone Company.—In anticipation of any possible litigation with the existing company, the New Company has, we understand, briefed and retained the following counsel:—Sir Farrer Herschel, the Solicitor-General; Sir Henry James, the Attorney-General; Mr. Horace Davey, Q.C., M.P., and Mr. Bousfield.

THE GÜLCHER ELECTRIC LIGHT AND POWER COMPANY.

THE report of the new board of directors of this company, to be presented at the next meeting of the shareholders, is before us, and when we say that the patents have cost (notwithstanding reductions) £71,879; that litigation has been commenced against Mr. Crookes for the return of all of the amount which he has received; that Mr. Crookes has applied to the Chancery Division of the High Court of Justice for the appointment of a receiver and manager of the business of the company, and that the company's cash is put down at £17, whilst the deficit to June 30th, 1883, was £18,678, and since then, for the last 15 months has been added another £20,672, it will be seen by our readers that the position of this company "is not a happy one."

The directors remark in the aforementioned document, that with a reasonable capital and a still further reduction of its standing expenses, and by ceasing to manufacture the "Crookes" incandescence lamp, they are confident that a good future would be before the Gülcher Company, but under present conditions they do not feel justified in continuing the struggle for existence without the special assent of the shareholders.

To the utter failure of Mr. Crookes' son, Mr. Henry Crookes, to manufacture a marketable lamp is ascribed much of the great loss sustained, and it stands to reason that if the inventor's own son, presumably working under the parent's advice, cannot make a good lamp, it is not to be expected that the directors can attach much value to the invention.

Language is used in this part of the report which is quite unmistakeable, and which places the Professor's dealings with the company in a most unenviable light before those concerned.

For the details of the report we would refer our readers to our "City Notes" columns, and, in conclusion, would say that the decision of the directors to take the opinion of the shareholders as to winding up the company or suspending its operations temporarily, are the only courses left open to them, and we should think the first is that which the shareholders are the more likely to pursue.

THE NATIONAL CONFERENCE OF ELECTRICIANS, PHILADELPHIA.

(Reported specially for the "Electrical Review.")

(Continued from page 386.)

Prof. ROWLAND: With respect to Mr. Thomson's remarks, I am very glad to see the matter taken up in this spirit, and to have my principles intelligently criticised. However, there was one remark which I wish to state immediately as an error, of course,

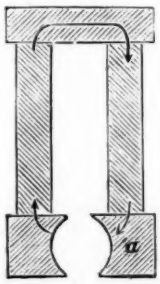


FIG. 3.

with regard to the steel. Steel can be magnetised to exactly the same degree as soft iron. There is no difference between soft iron and steel in that respect, except that you require an immensely greater force to magnetise steel to the same extent as iron. There are some old papers of mine, in 1873, I believe, which were published in the *Philosophical Magazine*, relating to experiments where I took iron and steel and several other metals and showed that the maximum magnetisation was the same in all cases, so that there is no difference between iron and steel in that respect.

But with respect to a number of statements with regard to flat magnets and round magnets I am very glad to see my remarks criticised in the manner that they were, because it shows the need of exactly what I stated; and that is experiments upon this subject. The question is one of quantity. My reasoning gave results in one direction, and Mr. Thomson gave reasons for making the magnet in another way, and it is a quantitative question of course as to which is the best; and for that reason I wanted very much to see experiments made in a manner which I have described, and by no means in this magnetic proof way, so as to find out what the escape of the lines of magnetic force in all cases is.

I think we can decide on one point that was brought up without any trouble, and that is with respect to the dynamo made in this

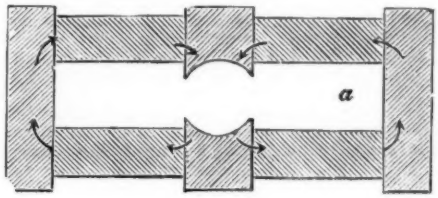


FIG. 4.

manner (fig. 4), where it was assumed that this magnet sent the lines of force down here, and that they cannot go around this way. In other words, it was assumed that the lines had a tendency to go in a particular direction, and that this was a sort of gun shooting the lines of force through the armature. That is not true, because they do not have any tendency to go that way at all, and you would only add that much to the area of the end of the magnet. Very few lines of force will go out there, and by putting this on you add to the area of the magnet. The lines of force will go out at the sides probably in greater numbers than they would at the end, so that I do not think that particular objection holds in that particular case. It is a question of quan-

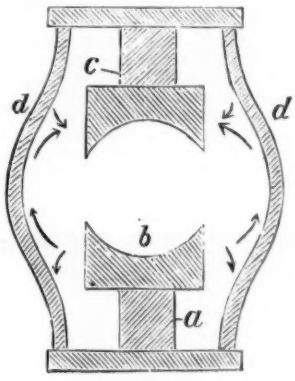


FIG. 6.

tity, the thing should be measured and found out. But I see very plainly in my own mind that more lines of force would go out the side of this thing by adding this iron here (*a*, fig. 4) than would go out at the end of it by leaving it vacant. Therefore I would prefer to have one circuit in the place of two. I believe more lines of force escape here (*a*, fig. 4) than in the other cases, but it is a matter of mere opinion. If there were more here (fig. 3) I do not think that would make up for having four magnets in the place of two. By having two magnets there is less surface for the force to escape than there was before. That is another reason for having fewer magnets. The surface is greater in the case of the larger number than of the smaller number; there is more surface for the lines of force to escape.

With respect to the other form of machines, I do not wish to get into a discussion as to these little points, but there is one point brought up here upon which I would like to make a remark, and that is with respect to the machine which was made this way (fig. 6). It was stated that there was some gain from the magnetic action of this coil on the outside. There is undoubtedly a gain—the question is, how much? The question is, whether more lines do not escape than would make up for that; and, if you have no experiments to go on, it is a case of judgment. My own judgment would be that there would be very little gain; but, as I said before, the thing should be measured up, and then we could find out about that point. There are other points I could mention, but I will not take up the time of the Conference.

Mr. KEITH: I have drawn upon the board diagrams by which I may illustrate the evolution of a machine that is at the Exhibition; and I will begin by the following description:—Suppose fig. 14 to represent two closed magnetic circuits, placed so that

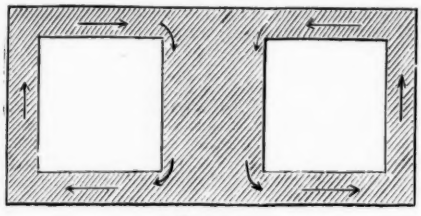
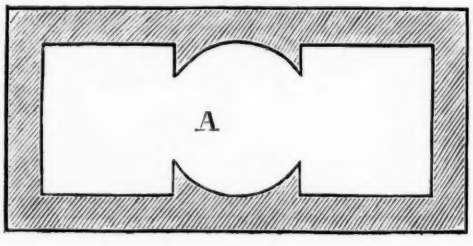


FIG. 14.

their polar ends are in juxtaposition; then there is no external induction; the magnetic circuits are complete. The magnetic current lines may be said to circulate in the directions of the arrows. The magnetic potential, then, if the mass be properly distributed, is the same at all points.

Now, according to the theory which is very well accepted, if we cross any of these magnetic current lines by wires we produce in these wires currents of electricity flowing steadily during constant

FIG. 15.



motion. As soon as we make a space here (A, fig. 15) in order to produce evidence of these lines of force, we introduce greater resistance to the magnetic lines, and the tendency is for a majority of the lines to cross from pole to pole, but others distribute themselves in various curves according to well-known laws. If we take this mass of metal and place it back again, and if it exactly fills the space, we by this act again close the magnetic circuit, and there will be no external indication of the field. Of course it will not be possible to pass wires between such surfaces; but, by taking out the core and turning it so as to make it smaller to admit of the passage of the wire completely around the core in this space (B, fig. 16), we will then obtain the highest possible

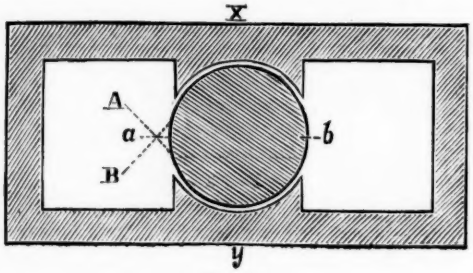


FIG. 16.

efficiency of field under that construction of the magnet and armature. If we then take this core and cut it transversely into a mechanically desirable number of discs and insulate them to prevent the formation of Foucault currents, we will then have a practical magnetic core, upon which is wound a wire of dimensions that fill the space between the core and the poles so constituted; and if this armature be rotated, the wire being connected with the proper collector, we will have the highest possible concentration of the magnetic force of these two magnets.

Of course, mechanically we cannot bring these surfaces into contact. We must allow room for the movements to take place, so we will let that space B be as narrow as possible. The result is then, the highest mechanically possible efficiency of the machine for the production of electric current. Furthermore, the greatest concentration of magnetic lines of force on this armature is upon the diametrically opposite points as shown by the line $x\,y$, (fig. 16); when this armature is rotated the currents are generated in the coils which surround it. The currents are taken off at points 90 degrees removed from the line $x\,y$, as at points a and b. The tendency of these currents is to magnetise the armature, so that the poles of the armature will be 90 degrees from the poles which are induced in them. If the space is considerable and there is not enough magnetic material of the core of the armature within the coils which surround it to make a complete closure of the magnetic circuit, there will be a distortion of the poles generated. In other words they will be moved forward by reason of the counteracting forces of the magnetic induction and the electro magnetic effect upon the core of the armature. But if this armature has been made as nearly mechanically perfect as possible, and the current which plays around it does not exercise a dynamic effect upon the core sufficient to distort the magnetic poles, there will be no necessity under the varying circumstances to which dynamo machines of constant potential are submitted, to move the brushes in the direction of the rotation.

This desideratum is obtained, it strikes me, by the machine referred to and with a very high degree of efficiency on that point. As practice always best illustrates a theory, I will state that I have seen one of these machines capable of supplying 200 incandescence lamps. One of the lamps being placed from binding post to binding post, 199 of them were switched off instantly. The remaining one at the binding posts, as nearly as I can form judgment by the eye (the others being out of range of the eye so as to avoid an error of judgment on that point), was not raised more than 5 per cent. in illuminating value. These machines show very nearly constant potential. There is no necessity for removal of the brushes to compensate for varying resistances in the external circuit.

It seems to me that a machine so constructed satisfies as nearly as mechanically possible the theory which seems to be most generally accepted, and that there are various points which might be stated about this machine as illustrating some of the points which have been brought before this meeting. One of them relates to the association of two magnetic circuits, producing what we call consequent poles. I understand (though I cannot speak from knowledge on this point, but I believe it) that when two magnetic circuits are placed in this relation, the tendency, or the result, is to concentrate the lines of force upon the true magnetic line, or the true line of division of these magnetic influences. Certainly the practical facts point to this—that where only one magnet is used there is under the laws governing the location of poles of magnets and distribution of magnetic lines, an entirely different field from that which exists under an association of magnets. There is a greater tendency to increase the magnetic strength of the points, or horns, as will be found by magnetic exploration. It may be that if the armature be proportioned in all respects to the field after the manner I have here shown that there will be a difference in the distribution of lines of force. They certainly will approximate better to the theoretical points than do some machines now at the Exhibition.

Prof. SILVANUS THOMPSON: Mr. President and gentlemen, I have a few criticisms to make upon some of the matters that have been brought before us this morning, and I propose also to intersperse my criticisms with some remarks of my own as I pass from point to point. In the first place, let me refer to the matter which Prof. Fitzgerald has brought before us of the apparent or spurious resistance caused in a rotating armature by the self-induction of the armature coils. The way which I prefer to regard this matter is slightly different from that adopted by Prof. Fitzgerald. I want to correct his formula in one respect. He wrote for the spurious resistance the product of the number of turns into the self-induction per section, into the square of the current of the machine. That is not the most convenient way of writing the expression as it does not fit conveniently into Ohm's law. We must remember that although there are two ways through which the current can traverse the armature, from brush to brush, there is only one way for the current in any one section of the armature coils. Let us write L for the coefficient of self-induction of the armature, n for the number of revolutions per second, and i for the current. Then, since the current in any one section of the armature is $\frac{i}{2}$ we shall have for the energy employed per second in starting or stopping the current in all the sections, $\frac{n\,\mathrm{L}\,i^2}{4}$, or,

$$\frac{\mathrm{W}}{t} = \frac{n\,\mathrm{L}\,i^2}{4}$$

Now, as the work spent per second in overcoming a resistance is

$$\frac{\mathrm{W}}{t} = \mathrm{R}\,i^2,$$

it follows that the effect of self-induction is the same as if there were a resistance of the value

$$\mathrm{R} = \frac{n\,\mathrm{L}}{4}.$$

Prof. FITZGERALD (interrupting): Will Prof. Thompson remember that I used the sign of variation instead of the sign of equality. You are right in saying that it should be "variable as." I was particularly careful not to write "equal."

Prof. THOMPSON: I want to be able to put it into Ohm's law, and write down the equation of the current, whatever it may be. It will be

$$i = \frac{\mathrm{E}}{\mathrm{R} + \frac{n\,\mathrm{L}}{4}},$$

where R is the real and $\frac{n\,\mathrm{L}}{4}$ the spurious resistance. I wish to

draw attention to this expression, because when Profs. Ayrton and Perry published something on this matter in their memoir on electromotors, they calculated the coefficient of self-induction, L, in ohms. I could not help thinking when I saw that, that there must be some mistake. A coefficient of self-induction is of the physical dimensions of a length, whereas in absolute dimensions resistance is of the nature of a velocity. There must be some term wanting in the calculations of Profs. Ayrton and Perry, and that term must be the reciprocal of a time. Suppose we write E for the electromotive force and i for the current. Then the equation for the activity or work per second of the circuit may be written, the activity, $E\,i$, being equal to the sum of the work spent per second in doing various things in the circuit, amongst other items being the work done in overcoming the mere resistance of the circuit. This work, expressed as $R\,i^2$ (per second), represents that part of the energy which goes in every second in heating the resisting parts of the circuit. To this we have to add the work done in building up the intrinsic energy of the magnetic field surrounding the conductors in which the current flows; this intrinsic energy being sometimes called the electro-magnetic inertia and sometimes the self-induction of the circuit. It may be written $L\,i\,\frac{d\,i}{d\,t}$. To this we ought to add the work done in increasing the energy of the field $N\,\frac{d\,i}{d\,t}$; and to that we ought to add also the term $i\,\frac{d\,N}{d\,t}$ if the strength of the field varies. Neglecting, however, this last term relating to the external field, which we may suppose to be constant, we shall now have

$$E\,i = R\,i^2 + L\,i\,\frac{d\,i}{d\,t} + N\,\frac{d\,i}{d\,t}.$$

Consider for a moment the first two terms of the right-hand side of the equation. If we take as the value of the current during any short finite time, t, as being i, then we may write $\frac{i}{t}$ for $\frac{d\,i}{d\,t}$, and the self-induction term becomes $L\,\frac{i^2}{t}$. We may then group these two terms together as $\left(R + \frac{L}{t}\right) i^2$. That is to say, there will be a spurious resistance equal to $\frac{L}{t}$; or, a coefficient of self-induction (which is a length) divided by a time is a velocity, as a real resistance is known to be. Now n in my former expression is simply the same thing as $\frac{1}{t}$ where t is the time of one revolution. Hence I am justified in expressing $\frac{n\,L}{4}$ as a resistance in ohms. Amongst other things, this shows us how the spurious resistance due to self-induction increases with the speed of driving. If we know the value of the spurious resistance for any given velocity of rotation, we can calculate the value for any other velocity; and therefore we are able to make a correction for different speeds of driving our machine. Remember that L is the coefficient of self-induction for the whole armature, and depends on the number of turns of wire, their area, and the cross-section, length, and material of the core. It does not depend on the grouping of the coils into sections; and, therefore, there will be the same spurious resistance (for the same speed of driving), no matter how many or how few be the sections into which the coils are grouped.

I would next draw attention to the effect of the grouping of the coils into sections upon another effect of induction. It is important to see exactly how and where the waste due to induction comes about. There is not necessarily any waste implied in the fact that the self induction sets up a spurious resistance: that merely makes the machine act like a smaller machine. Waste comes in whenever a coil in which a current has been induced is short-circuited on itself. In an ordinary armature of the Gramme or Siemens type the collector consists of parallel metal bars lying close to one another, and rotating under the brushes. There is a moment, as each commutator bar passes under the brushes, when the brush is in contact for a very short time with two consecutive bars, and the coil whose ends adjoin these bars is momentarily short-circuited. At that instant it forms no part of the circuit of the dynamo, being closed on itself. It is a neighbouring circuit; and instead of thinking about its self induction we have to think about the mutual induction between this little closed coil and the rest of the circuit. It is here that waste occurs. The instant this coil is short-circuited, the current that was running round it wastes itself in heat, and then a fresh current has to be started in it as it passes onward. The harm done will depend not only on the current in it, but on the number of turns of wire in that coil or section, The moral, therefore, is, that the number of sections should be made as large as possible in order that each section may have as few turns as possible in it. Another moral is, that the coil should be short-circuited on itself as brief a time as possible. I hold that it is absolutely wrong to put, as in some machines, two brushes at the top, and two at the bottom, one brush having a little advance over the other; because although you may apparently diminish sparking, you prolong the moment during which the coil is short-circuited on itself. I have noticed instances in which a spark was actually caused by the local current running round from one brush into the other through the coil that was short-circuited.

Passing from this subject to the more weighty consideration of how the self induction is related to the action of the machine as a whole, I propose to put the matter briefly into the form of a very simple equation. We may write for the electromotive force of the machine

$$E = 4\,n\,A\,H.$$

That is the form in which I have written the fundamental equation of all dynamos in a book which I have just written on this subject, and the proof sheets of which I hold in my hand. It contains, amongst other things, a theory of the dynamo. In this expression, E is the electromotive force, n the number of revolutions per second, H the average strength of the magnetic field in which the armature revolves, and A the effective or equivalent area of the armature coils. If you had an armature consisting of one turn of wire only, as it rotated it would cut a certain number of the lines of force of the field; and if the strength of the field and the speed were given, everything would depend on the area enclosed by the coil. If the coil consisted of more turns than one it would act like a single coil of proportionally greater area. If there were many turns and an iron core, it would act as a single coil of much greater area would do. It is possible in every case to find by experiment the area of the simple equivalent coil, and that equivalent area is called A in my equation. Now on which of these three variables does the self induction depend? If we wish to get a high electromotive force, we may do so by increasing either n, or A, or H, or all of them. But which of them is it best to increase? If you run the machine very fast and increase the factor, n, you may succeed in increasing E, but you also increase the deleterious reactions. There is more wear and tear, more friction of the bearings; and, worse than this, there will be more self induction, because n comes in into the quantity $\frac{n\,L}{4}$ which we found to express the spurious resistance. The spark troubles will also increase. Again, if you increase A, the effective area of your coils by winding them of a thinner wire so as to get on more turns, you will get more heating, because of the additional resistance, and you will also increase the self induction; for L varies as the square of the number of turns of wire. If, therefore, you want to get a high electromotive force, you must not run at a very high speed, nor have very many turns of wire on your armature. There is then only one way left; you must increase H, the strength of the field. This may be done simply by selecting the best iron of the best shape, and putting on it a sufficient weight of copper wire. None of the deleterious reactions increase when H is increased. I believe that the true progress of the dynamo for the next twelve months to come will lie in the direction of making the magnetic fields of our dynamos so immensely strong that we shall not have to employ many turns of wire, nor be obliged to run at an outrageously high speed. If once we get strong fields we may build simpler armatures and run at a slow speed; and this is mechanically and economically a gain. It will be a gain in other ways, too, for there are other difficulties besides sparking that come into play when there is a high speed, by reason of the complications which occur at the brushes. The lead of the brushes to which Mr. Keith alluded is a point in question; the lead will be both less in amount, and less variable, in the slow speed machine.

Now I come to the remarks of the President when he opened this discussion. He spoke about the shapes of magnets. I have made the remark in my lectures of two years ago that circular cross-section should be the best in theory, because it has the greatest area with the least perimeter. But it appears that in practice for very large machines a circular form is not found to be the very best form. Surely there must be some reason for this? If we take a pillar of iron of circular cross-section for our magnet, the iron at the middle is so far removed from the coils outside that it does not, at any rate, so soon get magnetised as the iron outside. Some people take the view that the outside layers act as a magnetic screen towards the inner part; others hold—and if it is true it is so much the worse—that the magnetism of very thick cores actually turns round inside and short-circuits itself through the interior. A simple experiment explains what such a state of things implies. If you will take concentric tubes of iron, one outside the other, and will magnetise them with a coil outside the outermost you will succeed in magnetising the outermost one; but some of the inside ones will show no magnetism, and, in some cases, you will find them actually reversed in their magnetism.

Prof. ROWLAND: There must be some mistake about this; it cannot happen so.

Prof. THOMPSON: I have tried it. Again, if we take a very thick bar of iron, magnetise it by means of a coil, and examine how the magnetism increases when we increase the current, plotting the curve for the relation between the two, we find that we do not in general get that which we ought to get if the magnetic permeability were what it is stated by high theorists to be. Let me explain that I have the greatest admiration for the work Prof. Rowland did some years ago on this matter of magnetic permeability. Without his work we should have known practically nothing on the subject. He told us just now that the magnetic permeability of a piece of iron under a varying magnetising force increases to a maximum and then dies away, as in fig. A; and that the effect of having copper, air or other non-magnetic material interposed in the gaps in the magnetic circuit would be to make

the curve of permeability flatter. If I remember rightly there were no gaps in Prof. Rowland's iron rings in which he found the permeability to exhibit these variations, and from which he deduced such high values as the maximum of permeability. Now,

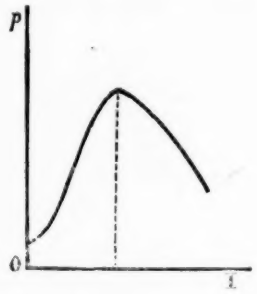


FIG. A.—CURVE OF MAGNETIC PERMEABILITY.

for all purposes of application to the dynamo, we are not working with welded iron rings, but with magnetic circuits in which there are gaps partly filled with air, partly with copper wire. We are therefore not concerned with the very high permeability to be observed only in a closed ring or in the middle bit of a very long bar. What we are concerned with is the permeability of our field-magnets and armatures as they are, particularly in relation to those parts of the field magnets which adjoin the space wherein the armature revolves. It may be true that the maximum permeability of soft iron attains the very high value of 2,000 or 2,500 in welded rings, or in the middle bit of a very long bar, but that is not really to the point. It may be true that the permeability begins with a small value, then rises as in that curve to a maximum, then falls again. It may be the truth, but it is not the whole truth. If it were, then this is what would happen when we magnetise any bar of iron, or any electro-magnet or field-magnet. If we began with a small magnetising force the magnetism of the bar would at first be small, then as the magnetising force was increased would increase. Plotting this effect out we get something like the lowest part of the curve in fig. B. This curve,

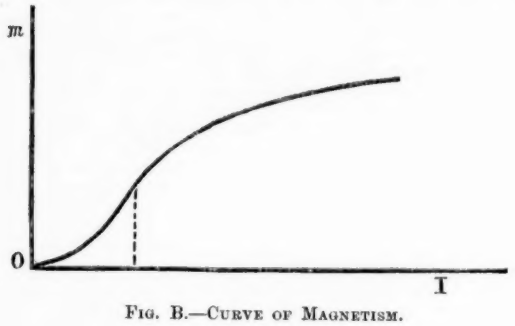


FIG. B.—CURVE OF MAGNETISM.

beginning at a gentle slope, would turn more sharply up at a point corresponding to the maximum permeability, and after that would become flatter again, gradually rising toward saturation, finally approaching a straight line limit. Now do we get such a curve as the curve of magnetism? No, never, when we work with short pieces of iron, or short thin bars. We never observe the hollowing of the curve in its early stages, and then a reversal of the

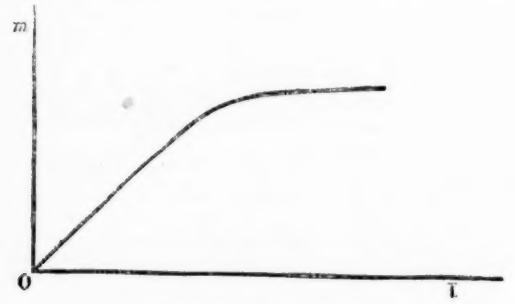


FIG. C.—CURVE OF MAGNETISM OBSERVED IN SHORT BARS.

curvature, unless with closed circuits of iron, or with very large masses of iron. Working with ordinary short pieces our curves practically rise in a straight line from the origin without any concavity, and then turn over, more after the fashion of fig. C.

What does this indicate with respect to the permeability of the magnetic circuit through the bar? Simply this. As there is no turning up of the curve there is no increase of the permeability after starting. In fact the permeability of the magnetic circuit

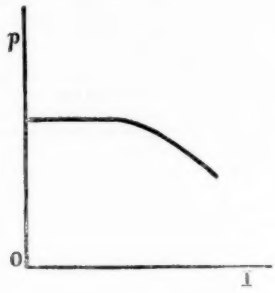


FIG. D.

must be more like fig. D than fig. A. Now the characteristic curves of our dynamo machines are simply curves of magnetism, provided we allow for the effects of self-induction in the coil and of certain reactions in the field, all of which would simply have the effect of making the curve turn down rather more. I am, of course, speaking of those characteristic curves, in which the two variables plotted out as a diagram are the magnetising current and the whole electromotive force induced in the coil. Well, the characteristic curves of our dynamo machines do not, except the machines have a very large mass of iron in them, or unless their magnetic circuit is very nearly a closed one, show at any time a hollowing in the curve as it rises from the origin. The magnetism of the iron in the so-called unsaturated state is proportional (very nearly) to the number of turns of the wire on the magnet multiplied by the current running through the coil: in brief, to the "ampère-turns." The curve runs up a sloping straight line and then turns round, and from this point on our magnetism begins to be got at a higher price. By doubling the current we no longer get double the magnetism. The very fact that in most dynamos we do not get such a hollow in the curve shows us that there is something wanting; that the dicta of high science about the permeability are not the whole truth; that the permeability of our iron-air-copper circuit taken as a whole will be something much more like fig. D; that it begins practically at a certain value, and keeps on at that value until a certain point is reached, when it turns down.

(To be continued.)

ON THE THEORY OF ALTERNATING CURRENTS.

OUR readers are aware that at the last meeting of the Society of Telegraph Engineers and Electricians Dr. Hopkinson read a paper bearing the above title. His remarks, however, were made particularly with reference to two alternating current machines connected to the same circuit, and we published in our issue of November 15th the pith of Dr. Hopkinson's investigations.

In our last week's columns Mr. H. Wilde, of Manchester, the inventor of the well-known machine bearing his name, and an able experimenter in electrical science, drew our attention to a paper read by him at a meeting of the Literary and Philosophical Society of Manchester in December, 1868.

This paper we reproduce below, and it will there be seen to what extent Dr. Hopkinson's recent discoveries have been forestalled.

Mr. Wilde's article was entitled: "On a property of the magneto-electric current to control and render synchronous the rotations of the armatures of a number of electro-magnetic induction machines," and proceeds thus:—

The discovery of the property which I am about to describe arose out of the efforts which have been made, during the last two years, to reduce the internal heat generated in an electro-magnetic machine by the induction currents set up in the electro-magnet and armature by the rapid magnetisation and demagnetisation of the latter. This heating of the armature (as is well known) was first observed by Dr. Joule in 1843, as the result of a delicate investigation on the quantitative relation existing between ordinary mechanical power and heat. In the electro-magnetic machines of my invention this phenomenon unfortunately manifests itself on an alarming scale, so much so that the armature of the 10-inch machine rises in the course of a few hours to 300° F. and upwards; and were the action of the machine to be continued for any lengthened period, the insulation of the armature coils would be in great danger of being destroyed.

One method of mitigating this evil was to construct the machine of smaller dimensions, so as to afford greater facilities for the dissipation of the heat by radiation and conduction. But even in the smaller machines an inconvenient residuum of heat

still remained when the machines were worked continuously for a considerable time, such as to render it desirable to adopt some means for abstracting the heat more rapidly. By means of a current of water circulating in the hollow brass segments which form part of the magnet-cylinder, Mr. Charles E. Ryder, the skilful manager at the works of Messrs. Elkington and Co., has happily succeeded in so far reducing this heating as to permit of the machines being worked for days and nights together without intermission, and without any sensible diminution of the power of the current.

The machines which have been found to be the most efficient and economical in their working are those which have armatures from 3½ to 4 inches in diameter. The armatures are driven at about 2,000 revolutions per minute; and the water, after having passed through the magnet-cylinder, is used for supplying the boilers which furnish the power for driving the machines.

I have already shown elsewhere that the current from a small magneto-electric or electro-magnetic machine is sufficient to excite the great electro-magnet of the 10-inch machine; and it has been further found, by my friend Mr. G. C. Lowe, that the current from one small machine is sufficient to excite simultaneously the electro-magnets of several small machines. In a number of 3½-inch machines which have been constructed under my direction for Messrs. Elkington and Co., for the electro-deposition of copper on a large scale, the currents from two 3½-inch electro-magnetic machines are made to excite the electro-magnets of twenty similar-sized machines to a degree sufficient to bring out the maximum dynamic effect of each machine. The electro-magnets of the two 3½-inch exciting machines are charged by the current from a small 2½-inch magneto-electric machine; but I have found that nearly as good a result may be obtained from the twenty machines by dispensing with the small magneto-electric machine, and employing the residual magnetism of the two 3½-inch exciting machines in a manner similar to that described, almost simultaneously, by Mr. Farmer*, Messrs. Varley†, Mr. Siemens ‡, and Sir Charles Wheatstone §.

So far I have adverted principally to the means by which a very serious defect in the practical working of the new induction machine was remedied, a defect which many of my friends, who were unacquainted with the efforts which have been made to overcome it, have considered to be fatal to the success of what seemed likely to be a useful invention. But while the difficulty arising from the heating was now obviated, the subdivision of the materials of one large machine into a number of small ones gave rise to another defect which it was also found necessary to overcome; for although the armatures of several machines might be driven nominally at the same speed from the said driving-shaft, by means of straps, yet when the combined direct current from several commutators was required, the want of perfect synchronism in the revolution of the armatures operated to produce a diversion of the currents of some of them through the coils of others, which were at the neutral point of their revolution; and consequently the maximum useful effect of the combined currents could not be obtained.

As the high speed at which the machines were driven precluded the employment of toothed gearing, the only method which seemed at all feasible for producing the requisite synchronism of the armatures was to place a number of the machines in a straight line, and connect them together by means of a clutch fixed on the end of each armature-spindle. The chief objection to the carrying out of this arrangement was the difficulty of providing the requisite means for preserving the synchronism of the system, when any of the intermediate machines were disabled by accident, or stopped for repairs; so that, practically, it would not have been found convenient to work more than two machines geared together in the manner described.

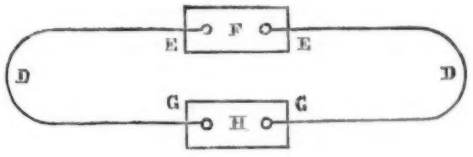
It was while experimenting with a pair of machines so geared together, that I first observed the phenomenon which forms the subject of this communication. These machines were arranged for producing the electric light, with a view to their application to lighthouse illumination. The armatures were 4 inches in diameter, and each of them was coiled with a copper-wire conductor, 280 feet long and ¼th of an inch in diameter. The currents were taken from the armatures by means of copper brushes rubbing against metal rings connected respectively with the ends of the armature-coils, and were therefore in alternate directions. It has been found that alternating currents are much better adapted for the production of a constant electric light at a fixed point in space than the current which has been rectified by means of a commutator.

The clutch, by which the armatures were connected, consisted of two iron discs about 4 inches in diameter, having, in the face of one, two iron pins which could be guided into two corresponding holes in the face of the other. These discs could be engaged or disengaged either when the machines were at rest or in motion. The relative positions of the pins and holes in the discs were such that the armatures might be engaged in reversed positions of half a revolution when required.

Each of these 4-inch machines, when making about 2,000 revolutions per minute, was of itself capable of producing a very efficient electric light; and when the two armatures were clutched together in such a position that the united positive currents from both machines proceeded from one polar terminal simultaneously with the united negative currents from the other polar terminal, the sum of the currents of the two machines was obtained. On the other hand, when the armatures were clutched together in the reverse position without any change being made in the armature connections, no current was produced outside the two machines.

These experiments, besides exhibiting the necessity of synchronous rotation, further showed that the armatures must also occupy the same relative position in the magnet-cylinders in order that the combined current from the two machines might be obtained. It now occurred to me to see to what extent the want of synchronism in the armatures would affect the magnitude of the current. The armatures were therefore unclutched and allowed to revolve independently of each other, in the same manner as when the attempt was made to take the combined *direct* current from the commutators. After the *alternating* current had been transmitted through the electric lamp for some time, I was surprised to find that there was no perceptible diminution in the amount of light produced from the carbon points, and that the current would melt very nearly the same quantity of iron wire as when the armatures were clutched together. On examining into the circumstances attending this unexpected phenomenon, I first observed that whenever the machines were stopped, the pins and holes in the respective discs were exactly opposite each other, and that, while the armatures were revolving, the two discs could at all times be engaged and disengaged with the greatest facility. Moreover, even when, before starting the machine, the discs were set a quarter or half a revolution out of the position in which the maximum amount of current was obtained, it was found that after the armatures had been revolving for a few moments, the discs resumed their normal position with respect to each other (as indicated by the action of the clutch), thereby exhibiting not only the synchronous rotation of the armatures, but also that the machines contained a principle of self-adjustment to the position in which the maximum effect of the combined current was obtained. It will, therefore, be evident that this property of the current, to maintain the synchronism of the armatures, renders it unnecessary to employ mechanical gearing of any kind for that purpose.

Proceeding further in this investigation, I found that, in order to produce synchronous rotation, it was not at all essential that the circuit which conveyed the combined currents for producing the light should be completed, provided that the ends of the coils of each armature were connected respectively with the same metal plates which formed the polar terminals of the machines. In this case the armatures adjusted themselves to their normal positions even more readily than when the current was producing the light. The accompanying diagram will assist in explaining these observations more fully.



Let D and D represent the two armature-coils, which, though each 280 feet long, may virtually be represented by a single turn; E, E, the two outer extremities of the coils, both connected by means of the metal rings and brushes with the metal terminal plate, F; G, G, the inner extremities of the same coils, similarly connected with the terminal plate, H. The synchronous rotation of the armatures and coils, D and D, as I have said, occurs either when the light is produced by the combined currents transmitted from the polar terminals, F and H, or when the circuit which conveyed these combined currents is broken.

The synchronism, however, is no longer preserved when a short circuit is made between the terminals, F and H, by substituting a good conductor for the carbon points, or for the long piece of iron wire which was melted. Nor, again, was this synchronism preserved when contact between the metal plate, H, and one of the ends, G, of the coil was broken. In the latter case it was observed that, whenever contact between G and H was made and broken, a bright spark appeared at the point of disjunction so long as the rotation was not synchronous; but when the synchronism was re-established only a trifling residual spark was visible.

Although the synchronous rotation was preserved when the terminals, F, H, from which the combined current was transmitted, were disconnected from the electric lamp, yet it will be seen, from an inspection of the diagram, that a complete metallic circuit was in fact always formed between these terminals through the coils themselves. Now, when the coils, D, D, happen to be at the same moment in that position during their revolution in which they are producing the maximum and minimum amount of current respectively, as must often be the case where there is no synchronism, that current which is at the maximum rushes through the coil which is producing the minimum current, as is

* Letter to the author, November 9th, 1866, Salem, Mass., U.S., Proceedings of the Literary and Philosophical Society of Manchester, February 19th, 1867.

† Specification filed at the Office of the Commissioner of Patents, December 24th, 1866.

‡ Specification filed at the Office of the Commissioner of Patents, January 31st, 1867.

§ Proceedings of the Royal Society, February 14th, 1867.

shown by the spark at the point where contact is broken between G and H. The effect of this passage of the current from one coil to the other is to accelerate or retard the rotation of the armature (according to the direction of the current) until synchronism is established.

That this influence of one coil upon the other operates in the manner described was easily shown by the following experiment:—The driving-strap of one of the armatures was removed, so that only one of the armatures should be producing a current, while the magnetism of the electro-magnets of both machines was, as usual, maintained to the same degree. On placing the stationary armature with its coil in a suitable position in relation to the magnet-cylinder for producing electro-magnetic rotation, and setting the other armature in motion, the stationary armature with its coil oscillated rapidly in arcs of very small amplitude, the oscillations corresponding in number with the alternations of the current. As the amplitude of the oscillations in this experiment was limited by the *vis inertiæ* of the armature, and in order that the effect of one pulsation only on the armature might be observed, contact was made and broken suddenly between the plate, H, and the end, G, of the coil by a sort of tapping motion, when the stationary armature was suddenly jerked round nearly a quarter of a revolution, sometimes in the direction in which it would have been driven by the strap, and at other times in the opposite direction, according as the alternating electrical wave which happened to be passing at the instant of making contact was positive or negative.

We have now seen, in the results obtained with the rotating and stationary armatures, a cause sufficient to account for their synchronism when revolving together, the absence of synchronism observed when the terminals, F and H, were bridged over by a conductor having comparatively little or no resistance being occasioned by the controlling current traversing the short circuit established between the terminals, F and H, instead of the 280 feet of resistance presented by either of the coils when approaching the neutral point of their revolution. The absence of synchronism observed when the direct current was taken from the machines by means of commutators, is caused by the direction of the current being coincident with that which they would receive by induction from the electro-magnets, and consequently opposite to that which tends to impart an accelerating or retarding impulse to the armatures.

Having obtained the full effect of the combined alternating currents from the two machines without any mechanical gearing, it yet remained to obtain the combined direct currents from the machines in the same manner. A pair of rings and a commutator were therefore fitted upon one of the armature-spindles, which was made sufficiently long for the purpose, and metallic connection was established between the rings of each machine and the commutator on the prolongation of the armature axis. As the commutator necessarily revolved synchronously with the two armatures, it was found that the combined alternating currents were rectified just as if they had proceeded from only one machine, and were consequently available for electro-deposition, or for any other purpose for which a direct current might be required.

Although this property of synchronous rotation has as yet been observed only in the case of several pairs and a triple combination of machines, yet there is no reason for supposing that it may not be extended to any number of machines that may be conveniently worked together from the same prime mover. It is necessary, however, to observe that as the controlling power of the current is only calculated to correct such minute deviations from synchronism as it is beyond the power of mechanical skill to prevent, the driving and driven pulleys should be respectively as nearly as possible of the same diameters, as the correction of any considerable difference in the number of the revolutions of the armatures, caused by differences in the diameters of the pulleys, must necessarily be attended by a corresponding diminution of the useful effect of the current outside the machines.

Before concluding this communication I wish to direct attention to an important property of the magneto-electric circuit which renders the commonly accepted theory, by which the generation and propagation of the electric influence in voltaic circuits is explained, inapplicable to those circuits which are entirely metallic. Reference to this property is all the more called for at the present time, as I find that a want of acquaintance with it has given rise to no small amount of misconception on the part of several eminent mathematicians and electricians who have examined my experiments on the electric condition of the earth, and the method by which I have thought proper to estimate the magnitude of powerful induction currents.*

The intensity of a voltaic current, as represented by the mathematical theory of Ohm, is equal to the electromotive force divided by the internal resistance of the battery; and from this theory it is inferred that an electromotor, in order to overcome a great external resistance, must itself possess a correspondingly great internal resistance. A further consequence deduced from this theory is, that the maximum useful effect of a given electromotor is obtained when the external and internal resistances are equal.

Now this mode of estimating the magnitude of an electric current does not apply to the circuits on the armatures of my machines. Taking for example the results obtained from the quantity-armature of a 10-inch machine:—The dimensions of the coil of this armature may be represented by a bar of pure copper, 67 feet long, and having a sectional area of 1·6 square inch; so that the resistance which this circuit presents to the passage of a current, when compared with that of the liquids in a voltaic battery, is practically null. When the coil is in full action it will melt 15 inches of thin iron wire ·035 of an inch in diameter, or the same length of ¼-inch iron rod with equal certainty, and will electrolyse acidulated water in at least 16 voltameters in series; so that the resistance outside the circuit, whether estimated by the 15 inches of thin wire melted or by the number of electrolysing cells in series, is more than a hundred times as great as that of the coil in which the current is generated.

Moreover, I have found that whenever a voltaic battery and a magneto-electric machine will melt an equal length of wire, the power which these electromotors have to overcome external resistance, as measured by the number of voltameters in series, is also equal. And, generally, the power of an electromotor (whether voltaic or magneto-electric) to overcome external resistance is directly proportionate to the length of wire which it will melt.

From a consideration of these results, it will be seen that one of the fundamental elements which enters into the theory of Ohm is found wanting when that theory is applied to the estimation of the magnitude of currents generated in circuits entirely metallic.

MM. Jamin and Roger, in a recent number of the *Comptes Rendus* of the Academy of Sciences,* have also pointed out the discrepancy here referred to in the application of Ohm's theory to magneto-electric circuits. I am, however, by no means prepared to admit the correctness of the views advanced by these physicists in their endeavours to reconcile the facts observed with established theory; besides which, other anomalies present themselves when the customary formulæ are applied to magneto-electric circuits, a consideration of which must ultimately lead to the enunciation of laws much more general in their application than those with which we are at present familiar.

P.S.—Since this paper was read, it has occurred to me that a comparison might be attempted to be drawn between the controlling power of the magneto-electric current over the rotations of a number of armatures, and that of the voltaic current over the oscillations of a number of pendulums. Beyond the fact that synchronism is produced in both cases through the agency of an electric current, there is no further resemblance between the two actions. In the case of the armatures the synchronism is produced by the mutual action of several rotating bodies upon one another, or by the dominant influence of several bodies upon one; whereas in the case of the pendulums the synchronism of the system is produced by the influence of one body alone upon several. Again, the synchronism of a number of pendulums is only accomplished by the skilful adaptation of means to an end, while the synchronous rotation of a number of armatures is a phenomenon which exhibits itself without the exercise of any ingenuity whatever; and, so far as I have studied this peculiar electro-mechanical action, no amount of ingenuity can produce the synchronous rotation of the armatures by means of the voltaic current, as magneto-electric currents and circuits seem absolutely essential to the attainment of this result.

* *Philosophical Magazine*, August, 1868.

* *Philosophical Magazine*, October, 1868.

ELECTRIC LIGHTING AT A PROFIT.

A FEW days ago a representative of the *Pall Mall Gazette* waited upon Mr. Hammond to learn from him the result of his experiment at Brighton in the supply of the electric light over a large area in open competition with gas, and this is the report of his interview:—

"Well, Mr. Hammond," said the reporter, "are we any nearer getting the electric light in our homes than we were at the time of our conversation in May last?" "Undoubtedly," was the emphatic reply of the sanguine electrician; "very much nearer than most people suppose, because there is a growing disposition on the part of capitalists to find the money for electric lighting stations from which the current will be supplied as gas is supplied." "Yes; but can you yet point to a town where you dispense the electric light as freely and readily as gas is dispensed, and make a profit out of the business? What, for instance, facts concerning your Brighton experiment?" "Well, there we are doing the very thing. We are supplying the electric light to customers all over Brighton by means of a complete system of town lighting, and we are not only covering expenses, but are also making a small profit, which can be increased to a good profit as soon as we augment our plant. And if you will go with me this afternoon to Brighton I will show you the first practical and successful attempt that has been made in this country to supply the electric light from a central station throughout a whole town."

AT BRIGHTON.

On arriving at Brighton, Mr. Hammond first called attention to the new railway station, lighted throughout with arc lights, all of which are on the town circuit, and are fed with the necessary current by a wire only one-sixth of an inch in diameter. The railway station is half a mile from the central station, so that all trouble connected with the generating machinery is taken off the

shoulders of the railway company. In the course of a ramble through the town the electric light, sometimes an arc light, sometimes incandescent lights, and all fed through the self-same wire, are met with at every turn. There are installations as far distant as the Grand Hotel on the one side and the Aquarium on the other, the middle of Western Road and the top of St. James's Street, all on the one circuit, and dependent on the same generating centre.

CHARACTERISTICS OF THE SYSTEM.

"How long has your systems of lighting been at work in Brighton, and in what does it differ from what has been done elsewhere?" "It has taken us three years to place ourselves in the position that we occupy to-night. The result of our labours here is that we have developed a complete pioneer town system which we call the Hammond-Wright, as the details have been most assiduously worked out by Mr. Arthur Wright, the gentleman who has had the management at Brighton from the very beginning. You will notice in the first place that only a very thin wire is used for the complete town circuit, and that the arc and incandescent lights are all fed through the same wire instead of through separate wires as hitherto. All this means the avoidance of a large expenditure upon heavy mains while working up the business. The whole current is used direct for efficient service in the lamps throughout the town, and is not frittered away by the interposition of secondary batteries or secondary generators. In fact, what the Hammond-Wright system has accomplished in Brighton is to turn the well-known powers of the high-tension current to good account for incandescent lighting, and by the invention of the necessary appliances for regulating and steadying the current, to make constant electric lighting on a cheap basis possible."

RATE OF CHARGE.

"What is your rate of charge?" "We charge ½d. per light per hour, and the consumer only pays for the actual number of hours the lamps are alight. Each consumer has a switch which he can use for turning off his lamps or any portion of them at any time, and the meter, which is fixed at every establishment, only registers while the current is flowing." "And how does your charge compare with gas in the town?" "Gas in Brighton is 3s. 3d. per 1,000 feet, and the electric light comes to about double that; but those who have taken the electric light consider that they more than save the difference in the depreciation of stock and destruction of decorations, for which gas is so largely to blame. One jeweller says with the new light he can dispense with one boy hitherto constantly employed in cleaning goods tarnished by the gas jets, and as six jets throw into the atmosphere one gallon of water every five hours, and the electric light does nothing of the sort, you will not wonder that drapers are some of our best customers among the tradesmen."

ELECTRIC LIGHT CUSTOMERS.

"Do you find the light readily taken up?" "Very readily; indeed, now it is seen that we can supply a constant light by meter, and so give our customer complete control over his consumption, we have many more applicants on our books than we can deal with. We are just now busily engaged in the work of enlarging our central station in order to make room for 200 additional horse-power, when we shall be ready to supply 2,000 more lights. We have not put the light into any private house yet, nor can we afford to do so until the more pressing and profitable business of lighting business premises has been fully provided for. At present our customers include provision-dealers, drapers, jewellers, restaurants, chemists, bootmakers, butchers, clubs, hotels, a circus, theatres, art-dealers, auctioneers, photographers (who use it for photographic purposes), and the Chapel-Royal."

OVERHEAD *v.* UNDERGROUND WIRES.

"I notice that you are using overhead wires. Is this a necessary part of the Hammond-Wright system?" "By no means. At Hastings and Eastbourne, where we are introducing the same system, we shall depend entirely upon underground wires. In Brighton we put the wires overhead because we have no powers to put them underground, whereas the Corporations of Hastings and Eastbourne have granted us the necessary powers for laying underground wires, and we have readily availed ourselves of the permission. Of course, as a matter of fact, it is very much cheaper to run overhead wires, because no insulation is necessary."

THE ELECTRIC LIGHT AT A PROFIT.

"Then you think you have solved the question of supplying the electric light at a profit and at a reasonable charge as compared with gas?" "I do. Even with our present limited plant our returns at Brighton leave a margin of £600 a year to cover depreciation of plant and a small interest on the money invested. Of course, in this calculation I treat the Brighton station as entirely separate from the operations of our company, regarding it as containing so much machinery erected to perform certain work."

THE CENTRAL STATION.

"Here," said Mr. Hammond, as we entered the engine-house, "you will see every appliance necessary for generating the current, and distributing it in a steady and constant supply throughout the whole circuit of our 8 miles of wire. If, for instance, to the number of lamps alight in the town there are added even the small number of 10, an automatic apparatus rings a bell, announcing that the current throughout the whole circuit has been weakened by the absorption of the current necessary for that number; the current, however, will immediately adjust itself to the altered conditions. To ensure this action we keep a man constantly watching a self-registering apparatus, and if the current varies much for a minute he is fined a shilling, as it is his business to keep it steady and constant throughout the whole circuit. Again, if 10 lamps are turned off another bell rings, announcing that the current throughout the whole circuit has been strengthened, and again the self-adjustment will act. Another instrument shows the quantity of current which is flowing in the circuit at any particular time, and another indicates the number of lights which are alight at any time. Indeed, it is by dint of the self-regulating instruments that the Hammond-Wright system has been brought to its present perfection, and has produced the satisfactory results which you have seen over some 8 miles of circuit throughout the town."

THE ORGANISATION OF THE POST AND TELEGRAPH SERVICE IN FRANCE.

(*Continued from page* 412.)

Gutta Percha.—It has been noticed for some considerable time that the gutta percha supplied by the trade for the manufacture of telegraph cables frequently contains adulterated matter.

The price of this article is steadily increasing; it becomes more and more difficult to obtain it, and it is to be feared that one day it may fail us altogether.

We are therefore trying to find a remedy against this evil.

The trees which yield this gum exist in countries into which civilisation has scarcely penetrated; they are to be found especially in the midst of the forests of the Malay Archipelago. The natives alone collect the gutta percha, and sell it to Chinese merchants, who re-sell it again to Europeans.

These go-betweens first deduct a profit, which increases the price enormously. The collecting is done in a very wasteful manner, without the slightest management. The trees are simply cut down, and, in order to facilitate the immediate yield, all future collections are thus sacrificed.

We have charged an engineer of the telegraphs, Mr. Seligmann-Lui, with the mission of studying in detail the production of gutta percha, and to make the necessary inquiries to allow of improving the present situation.

During an often dangerous exploration in Singapore, Sumatra, and in a part of Indo-China, Mr. Seligmann-Lui has gathered valuable information as regards the places where the gutta percha trees grow, and the manner of collecting the gum. He has brought home a great number of samples and young plants of the different kinds of trees which yield it.

We are considering, together with the Minister of Marine and Colonies, if it would not be possible to acclimatise this valuable tree in Cochin-China, or in any other part of our possessions. We hope to succeed in this.

Underground Lines.—Overhead telegraph lines are exposed to numerous accidents, and to interruptions caused by atmospheric disturbances and storms; it is especially during the winter that those accidents occur more frequently. Notwithstanding all the promptness of the officials employed in repairing such damages, this may lead to interruptions in the communications which may last for some time, and such interruptions are essentially prejudicial to the general interests of the country.

It is thus that the French lines have suffered on different occasions, especially during the winters of 1879-1880, and of 1880-1881. In consequence of an exceptional glazed frost, Paris has found itself, for the moment, nearly isolated from the greater part of France.

No doubt this situation was only a passing one, and the officials of the technical service quickly restored matters to their normal position. The interruption in the communications, nevertheless, lasted for several days. The same accidents occurred recently in the north-east district.

More serious accidents have been reported in the United States, and in England. In the month of January, 1881, London was also deprived of nearly all telegraphic communication with the outer world. A similar fact occurred more recently in the same city in the month of October, 1881, and in the beginning of the year 1884. We could easily mention similar interruptions of recent date in other countries, especially in Spain.

Since 1879 we have been obliged to consider the question of assuring the permanency of our communications; we could not succeed in this but by submitting to the heavy expenses of establishing an underground system. It was owing to its underground cables that Germany did not suffer from the atmospheric disturbances which took place in that country at the same time as in France and England.

The first trials of underground telegraphs, made in Prussia in 1846, did not give, from the very first, the results that had been expected from them.

But the German Government, after reconsidering this first impression, resumed the work in March, 1877; the last section of the first project, that from Cologne to Aix-la-Chapelle, has been completed on the 30th June, 1881. The number of towns thus placed into communication is not less than 221.

The 23 wires which compose this part of the German system

have a length of 5,471 kilometres, representing 37,426 kilometres of wires, and have already cost over 50 million francs.

Since then the obtained results have determined the German Government to undertake the laying of a new series of underground lines.

In England and in America a movement of opinion seems to make its way in the same direction.

The underground system is intended to assure the continuity of the telegraphic transmissions; it does away with the uncertainty of the interruptions which nearly every year paralyse large parts of the overhead system.

Even without these exceptional interruptions, there are various occurrences such as contact between the wires, or atmospheric influences, which frequently delay the work without completely interrupting it.

From a military point of view, the establishment of underground lines is of the greatest importance, as stated by me, on the 16th December, 1882, to the Chamber of Deputies, in the following words:—

"It is disputed that underground cables can be of use from a military point of view. However, as I have recently told you, it is the War Office itself which has declared that the establishment of this system is to the interest of the defence of the country, and it has been right in that assertion.

"Indeed, if at the time that whatever mobilisation be necessary, any serious atmospheric disturbances should take place, and if, in consequence of this, the overhead system could not be worked at all or only partly, we would be exposed to a great danger: the mobilisation would be stopped and could be so, even for several days. Can a country that wishes to be safe against any aggression, accept such a situation? Certainly not! That is the reason why Germany has established an underground system; that is why we have done well in following her example. She has thereby made sure, at all times, of her telegraphic communications. I do not wish to enlarge any further on this question. The underground cables form one of the elements of national defence."

Before undertaking the laying down of the underground lines, we have appointed a large committee, charged to superintend and to settle all the technical questions which may arise.

The conductors of the underground lines, to the number of three, are laid up in cables. On the principal lines several of those cables are enclosed in cast-iron pipes; the accessory lines only consist of a single cable, protected against any action from outside by means of a sheating of iron wires. In case of accidents, special instruments allow of determining with preciseness the faulty spot, and the examinations to be made are thereby limited.

Our cables are manufactured in France; as regards strength, they are second to none of any other country, and we feel confident that their special arrangements improve the electrical transmission. We have our cast-iron pipes made in French factories. We have thus developed in our country a new industry. We submit the work to be executed in the factories to public adjudication. These measures have enabled us to lay our cables at a very moderate price.

If an account be kept of the fatal interruptions of the overhead lines, of their forced inactivity at certain times, it will easily be seen that the underground lines, even for long distances, finally give better results, owing to their permanency and their regularity. Several lines are completed and opened to the public service.

It is in this way that for more than two years the service between Paris and Soissons takes place with the greatest regularity, without having given cause for the slightest mishap.

The lines to Lille, Lyons and Nancy have more recently been opened. The obtained results are stated in a document emanating from a special official, the "Directeur du Matériel et de la Construction."

"The Minister," says a report of that official, dated the 18th November, 1882, "has requested me to report to him the results obtained, both as regards the working of the underground lines and the degree of security they afford. I have only to mention to him the facts:—

"In the direction of the east, the service is thoroughly established by the underground lines between Paris, on the one side, and Soissons, Reims, Châlons and Nancy on the other. This service works very regularly and, by means of a special arrangement of the instruments, with the same speed as obtained on the overhead lines. We have recently obtained the same result between Paris and Lille and between Paris and Dijon. Within two months we hope to reach Lyons in the same manner:—

"However, you have instructed a committee, composed of a Director of your Administration and of two General Inspectors, to go to the places and to report to you.

"This committee has stated that the working of the underground wires was such as I have reported."

The chairman of the committee added to the note of the "Directeur du Matériel et de la Construction":—

"On the 18th November inst. the *Journal Officiel* informed the public that the telegraphic transmissions were delayed, owing to a magnetic storm. This storm has not influenced the working on the underground lines, which all have a double wire."

Moreover, for several days we have had rapid senders connected up to the different underground lines, and we have placed them at the disposal of the Members of Parliament, by inviting them to come and assure themselves of the regularity of the working of this system.

A great number of Senators and Deputies answered to this invitation, and were able to correspond with the different towns connected with the system.

The sums already voted for the underground systems amount to 36,500,000 francs.

Soon Marseilles and Bordeaux will be able to correspond with Paris through the new lines.

The network could easily be completed within a short time, if we had the necessary amount of money voted for that purpose. When, at a sitting of the Chamber of Deputies, one of my colleagues expressed the fear that one did not seem to be induced to extend the programme of constructing underground lines, he proved their usefulness better than anybody. He thereby stated precisely the great advantages offered by these lines.

Moreover, in such questions, in order to be provident, it is well to limit one's self to what is necessary and to what prudence requires.

We read the following in *La Lumière Electrique* of the 15th inst.:—

"The Committee of Supply has refused to grant the 800,000 francs asked for by the Ministry of Posts and Telegraphs for the construction of underground telegraph lines. It has also refused the sum intended for the establishment of a Superior Telegraph School."

(To be continued.)

TELEPHONY IN THE FUTURE.

THE terms under which the United and any other Telephone Company are to be licensed by the Postmaster-General will be received with satisfaction in many quarters. The shareholders of the company themselves probably foresee an increased prosperity to their business, and a consequent financial benefit to themselves. Already the announcement of the new terms to be granted by the license have given a decided upward tendency to the shares of the United Company, but whether this increase in value is entirely justified by the circumstances of the case is somewhat doubtful. In the favourable nature of the terms, and the large scope of the concessions, the desire of the Government authorities to afford great facilities for telephonic enterprise, even at the risk of possible loss to themselves, is shown. That the monopoly of these concessions should remain with the United Company appears hardly likely; such a state of affairs would be quite contrary to the spirit in which the Government has dealt with the question. In fact, as our readers may remember, the late Postmaster-General distinctly stated that it was not intended that such a monopoly should exist. Up to the present, the United Company has practically had it all its own way, and the result has not been entirely satisfactory to the public. The latter, indeed, has had much to complain of in the inefficient manner in which the exchange services have been carried on. Complaints, indeed, have produced but little effect in the absence of competition. All this, however, is not unlikely to be altered, as the favourable terms on which telephonic communication may be licensed to be carried on will probably bring competitors again into the field, and the United Company may again have to engage in a costly warfare to protect its interests, and with less chances of success than formerly. Since the great contest between the United and the Globe companies was decided in favour of the former, a large amount of work has been done, not only in the direction of designing new telephones and telephonic apparatus, but also in collecting evidence and facts with reference to the validity of existing patents, and this may be utilised with more chance of success, especially as the experience of the last great fight may be made effective use of. Unhampered by the former restrictions, there is, we believe, a very fair future for telephonic enterprise in this country, especially if competition forces the much needed improvements in the inter-communication system to be carried out. Already there are signs that the monopoly hitherto enjoyed by the United Company is not to remain unchallenged, and the terms under which working may now be carried on will probably do much to induce the investment of more capital, although up

to the present heavy loss has been the only result of attempted competition.

The unsatisfactory way in which the inter-communication system has hitherto been dealt with is no doubt in a very great measure due to an inefficient supervision of those employés whose duty it is to attend to the calls of subscribers, and possibly also to the exchanges being undermanned, but a great deal is also due to the somewhat antiquated system employed. The number of different methods which have been devised for effecting inter-communication with dispatch by means of mechanical contrivances is very large, and although, no doubt, a great many of the ideas are wanting in practicability, yet in the mass some useful suggestions exist which might be followed out with advantage.

To attempt a purely mechanical automatic system is, we believe, a mistake, as the inconvenience caused by possible failures would more than counterbalance any gain which the contrivances would afford.

Much is expected to result from the fact that no restriction is to exist as to running trunk wires from town to town, but we believe that the demand for such inter-communication is much over-estimated, there being but comparatively few centres between which much telephonic business is likely, for some time to come, to be carried on. That some cases do exist, however, is undeniable, and here the need for greatly improved instruments will probably delay the communication being effected. That long-distance telephony in this country will be possible is, we think, undoubted, but hitherto success in this direction has not been attained.

The erection of a wire of large gauge on a special line of poles between the centres would effect the desired object, but in an expensive manner, and probably not with the complete success desired if the existing forms of instruments are used.

The recent concessions, therefore, will have the effect of stimulating competition, which will necessarily compel an improved telephonic service, which in its turn will greatly assist the extension of telephonic communication.

NOTES.

Electric Lighting.—Last week as Her Majesty journeyed southwards, the Queen's dining-room at Perth was made the scene of an interesting display of electric lighting, by means of the Lalande primary battery. The battery consisted of 60 cells, in the form of malleable iron pans, each measuring about 15 inches by 10 inches, and having a depth of about 2½ inches, only a section of which, however, was in circuit. Wires were run from the ante-room to the table of the dining apartment, where they were connected with silver candelabra, whence the light was diffused from three Swan lamps upon each. The sockets of the candelabra were occupied by hollow wax tapers, through which the wires were taken, and the lamps were shaded by covers of an agreeable pink tint. The opinions of Her Majesty regarding it were expressed in a most complimentary manner, while her interest in the *modus operandi* of the invention was also evinced by a close inspection of the apparatus and a variety of interrogations regarding it. The battery and attachments were erected by Mr. Boothby, C.E., Springfield House, Cupar Fife, by whom a concession has been obtained of the patent rights for Scotland.

Mr. Innes, chairman of the City Commission of Sewers, stated at a meeting last week of the Court of Common Council, that there had been no delay on the part of that body in dealing with the question of electric lighting in the City, and they had stated their readiness to receive tenders. Only recently they had received an offer to supply the electric light at about the same cost as gas, and the company was willing to give large security for the due carrying out of the contract. A deputation of the Commission had seen the light in operation at the large manufactory of Messrs. J. and J. Colman at Norwich, and were highly pleased with it. The matter would now soon be concluded.

Temesvar, which had been successfully lighted by electricity since the beginning of the month, was suddenly thrown into complete darkness on the evening of the 23rd inst., owing to a sudden breakdown.

Messrs. Anderson and Munro, of Glasgow, have for some time been engaged in fitting up afresh, and on a more extensive and complete scale, the electric lighting arrangements of St. Enoch Station, which is the terminus of the Glasgow and South-Western Railway in that city. This station, we believe, was amongst the very first in the United Kingdom to be lighted by electricity; and at least three different firms have had contracts for "running the lights." Whatever want of success may, from time to time, have attended the St. Enoch installation, has been due in great measure to the prime motor, which also drove the laundry machinery and did other work in the large hotel connected with the station. It is now several months since the last contract terminated, and before fresh tenders were taken in for continuing the electric lighting of the station, it was resolved by the directors of the railway company to erect a fresh engine and boiler-house. The new arrangements, which are now being carried out under the advice of Mr. Watson, one of the directors, will include the use of three dynamo machines, 34 Brush arc lamps, and between 200 and 300 incandescence lamps. Two of the machines will each provide current for 17 Brush lamps, and the other will be a Victoria 300-light dynamo. In the station proper there are to be 32 arc lamps in four lines of eight each, and the remaining two will light the booking hall. The incandescence lamps will be chiefly employed in lighting the principal floor of the hotel, in which gas has hitherto been exclusively used.

On the 18th November, on the occasion of an "At Home" given at Surrey House, by Mrs. Horniman, the reception rooms and adjoining museum were brilliantly illuminated by an installation of the electric light by means of incandescent lamps. The current for these was supplied by storage batteries which were sent from the Electrical Power Storage Company's works at Millwall, ready charged.

Mr. Ernest Hart read a paper before the Society of Arts on Wednesday evening, on "The Health Exhibition: its Influence and its possible Sequel." Concluding the paper, he referred to the lesson of the Exhibition as to open-air recreation and the electric lighting of public parks. It appeared to him to be no small disgrace to this great metropolis that, in the very centre of its crowded districts, within an arrow's flight of the houses, probably, of most of those who were present, there lay great open spaces, such as Hyde Park (but what he said referred also to Victoria Park), which at night were dreary, desolate areas of darkness, which were unlighted, which were dangerous to cross, which were unused in the evenings for any wholesome or moral purpose, which were often scenes for the display of some of the worst vices incidental to the lowest dregs of the population of the great city. Hyde Park could be adequately lighted with the electric light for an annual expenditure of £5,000. He thought such a sum trifling compared to the happiness, enjoyment, and health it would confer.

The experiment in train lighting by electricity, which for the past 11 months has been proceeding on the London, Brighton, and South Coast Railway, having proved successful, an official inspection by the Board of Trade took place last Tuesday evening, when the board was represented by Major-General Hutchinson, Colonel Yolland, C.B., Colonel Rich, Major Marindin, Major Armstrong, and Mr. Calcraft. Amongst the visitors who took part in a trip to the Crystal Palace and back were the Marquis of Tweeddale, Lord Sudeley, Lord A. Gordon-Lennox, Lord S. Cecil, Lord Cadogan, Sir Henry Tyler, M.P., Sir Daniel Cooper, Sir P. Rose,

Sir T. Farrer, Colonel Sir A. Clarke, Mr. John Holms, M.P., Mr. John Pender, M.P., Mr. Laing, M.P., and others interested in electric lighting. The first attempt at train lighting by the electric light by the Brighton Company was made several years ago, when the Pullman express was so illuminated, the current being obtained from secondary batteries. The system now in use is that devised by Mr. Stroudley, the locomotive superintendent, and Mr. Houghton, the electrician. A Brush dynamo, weighing about 8 cwt., is placed in the guard's van, where are also a number of accumulators. The train is made up of three first-class, two second-class, one composite and five third-class carriages, and is lighted with 32 incandescent lamps of 16 candle-power each, 14 of these being in the first-class, 8 in the second-class, and 10 in the third-class carriages. Power is utilised from the revolutions of the axle of the guard's van, with which the dynamo is connected by an arrangement of counter-shafting and belting. The dynamo, however, does not come into action until a speed of 20 miles an hour is attained by the train. When the accumulators are fully charged the supply ceases automatically, and is automatically recommenced when necessary. The installation is entirely under the control of the guard, who may at any time turn the current on or off—say, when passing through a tunnel in the daytime. Since December last, the train has made 2,352 trips, and has run 27,322 miles, and the working has proved very satisfactory. The company has another suburban train similarly lighted, as well as the 5 o'clock Brighton train, and a fourth is now to be fitted up. The installation in the train inspected on Tuesday was carried out by the Railway Electrical Contractors, Limited, of 4, Great Winchester Street. Our readers will perhaps remember that we have on several occasions described and criticised the Stroudley-Houghton system.

Train lighting is also attracting attention in America. A carriage on a railway in Massachusetts has recently been lit by Woodhouse and Rawson's incandescent lamps.

At Lady Filmer's fancy dress ball, at Maidenhead, on Wednesday last, the rooms were lighted by Messrs. Woodhouse and Rawson's incandescent lamps. The current for these was obtained from the Chuffs, about a quarter of a mile distant, the residence of Colonel Fremantle, which was lighted by Messrs. Woodhouse and Rawson permanently some time ago. The work of running the cable to connect Colonel Fremantle's residence with Lady Filmer's was only commenced the day before the ball, but not the slightest hitch occurred with the lighting. The colours of the fancy dresses were well displayed by the electric light, and the effect of the lighting of the supper table in the conservatory was especially good. Miss Fremantle wore a flower lighted by a small lamp inside, the current being supplied from a Woodhouse and Rawson small portable accumulator carried in her dress.

Messrs. Howell and Son's saw mills at Llanelly have recently been lighted by electricity, the installation having been carried out under the direction of Mr. J. C. Howell, who has a laboratory for experimental purposes adjoining the mills. In this laboratory are placed a Crompton-Bürgin self-regulating dynamo and a Marshall horizontal engine, fitted with automatic expansion gear and Hartnell's governor. The laboratory is lighted by six lamps. In the mills there are 24 lights, distributed thus:—Two boilers, 1 each; engine-room, 2; old mill, 45 ft. by 35 ft, by 16 ft., 10 lights; new mill, 45 ft. by 14 ft., 3 lights; tool shed, 30 ft. by 20 ft., 3 lights; basement underneath mill, working all day, 4 lights. For ordinary work the lamps are placed slightly higher than gas-jets, but throw a glowing light on all the benches, and if it is found necessary for minute purposes to obtain more light, the whole of the lamps are so arranged that they may be easily drawn underneath the benches, or carried by the hand to any place found necessary.

The Brush Electric Company in America was given leave about a year ago to light up Delaware Avenue, in Philadelphia, with its light. The Callender Company, of London, was given the contract to lay its patent cable 18 inches under the pavement, which was done, putting the cable in a bed of four inches of sand. The lights worked well for a short time, says the New York *Electrical Review*, but then they commenced to get weaker night after night, until now they won't work at all, having developed into a complete failure.

The Austrian Minister of Justice has had experiments made with the electric light in the prisons of the Empire. If the light gives the results which are confidently expected, it will be adopted for the new prisons in course of construction at Prague and Marbourg.

The Post Office and the Telephone Companies.—The following communication from the secretary of the United Telephone Company was posted up in the Stock Exchange on Monday last:—"Dear Sir,—I am requested by my board to acquaint you that the new form of license for this company has been to-day received from the Postmaster-General. The license is for 31 years from the 1st of January, 1881, and the following are the principal points on which concessions have been made:—The license contains no limit of area nor restriction as to running trunk wires from town to town. Call offices may now be opened, whereby members of the public can communicate with subscribers. The claims of the Post Office to provide in the license for the supply of telephones to the department by the company, and the proposal that the company should pay a royalty to Government upon private wires erected and maintained by it have been given up. By a separate agreement Telephone Exchanges may be connected with the Post Office, and subscribers may send and receive telegrams by telephone." In connection with this subject we would draw attention to an article which appears in our other columns, entitled "Telephony in the future."

The Telephone on the Continent.—The *Times* states that a plan for establishing telephonic communications between Brussels and Paris is being considered.

Conversazione of the National Telephone Company.—On the night of the 21st inst. the National Telephone Company, Limited, held its fourth annual conversazione in the Victoria Halls, West Regent Street. A large number of the employés and their friends assembled. Mr. W. A. Smith, director, who occupied the position of chairman, in the course of the evening delivered a short address. Referring to the progress of the company, he said the number of people who had benefitted by its labours was increased by a hundredfold, while the revenue had increased by a hundred per cent. In consequence of the liberal concessions made by the late Postmaster-General it was possible, and indeed in a short time it would be an accomplished fact, that every village of any importance would be connected by telephone. As a matter of interest he mentioned that the number of calls in the National Telephone system alone for the last month amounted to 684,000. During the evening dancing was carried on with zeal.

The Telephone in Berlin.—Lawyers utilise the telephone considerably in Berlin. The solicitors of the town have combined to obtain a room in the law courts, whence a telephonic wire is laid to their offices, enabling the members to communicate with their clients until the very beginning of a suit.

Communication between India and Ceylon.—A cyclone has been experienced on the north coast of Ceylon; telegraphic communication with India was cut off for several days, both lines in Southern India being broken, and the whole country being under water.

The Mackay-Bennett Cable.—The New York end of the Bennett-Mackay ocean cable is being hung on hooks under the Brooklyn Bridge. It is 3,400 feet long, and weighs 45,000 lbs. The various companies that hang their wires across the gigantic structure pay about $8,700 for the privilege per year, and the cable companies' share of this is $250.

The Telegraph in the Soudan.—A Reuter's telegram from Dongola on the 21st inst. intimated that the telegraph section had arrived there, having laid 35 miles of wire in seven days. The local line from Haffir is under the direction of Lieutenant Tower.

Egyptian Telegraphs.—The *Times* correspondent at Alexandria states that the military authorities have leased the Egyptian telegraph lines, south of Cairo, for £3,600 monthly.

Speaking to Yokohama.—As an instance of rapid telegraphy, says the *Japan Mail*, the following item from the records of the Yokohama telegraph office is not without interest :—A telegram was handed in at Yokohama at 3·10 p.m., and was received in London at 8·27 a.m. (time of transmission, 2 hours 37 minutes). An inquiry arising from the message was given in at London at 10·43 a.m., and received in Yokohama at 8·40 p.m. (time of transmission, 37 minutes, deducting 9 hours 20 minutes, the difference in time between London and Yokohama). The reply was forwarded from Yokohama at 9·50 p.m., and reached London at 3·21 p.m. (time of transmission, 2 hours 51 minutes). Thus the whole transaction—forwarding the telegrams, the receiver in London making further inquiry, the examination at this end before replying, and the delay occasioned by the messages having to wait their turn for transmission—occupied as nearly as possible the time of the sun's passage between the two places.

The Telegraph in Central Asia.—The Russian Ministry of War has decided upon the immediate construction of a telegraph line from Askabad to Merv, *via* Anno, Babadurma, Bugatchik, Artchingan, and Sarakhs.

Post-Office Extensions.—A Bill is to be brought before Parliament to give power to the Postmaster-General to acquire by compulsion lands, houses, and buildings in London, Birmingham, Bristol and Newcastle-on-Tyne, for the purpose of extending various post-offices.

The New Postmaster-General.—The Press Association states that Mr. Shaw Lefevre, the new Postmaster-General, formally took up his position at the Post-office on Friday, last week. In the course of the day he received a deputation from the Corporation of Birmingham with reference to their post-office. Pending the appointment of a successor, Mr. Shaw Lefevre will carry on the duties of his former office, First Commissioner of Works.

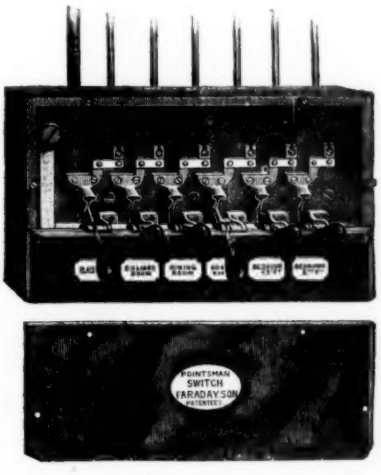
Gas Explosion in a Church.—On Sunday morning, at the Presbyterian Church, Dartmouth Park Hill, Highgate, an explosion of gas took place in the vestry of the church. The church officer, thinking he smelt an escape of gas, struck a match in order to test the point, when a violent explosion occurred, the windows of the vestry being blown completely out. The officer was badly burnt.

The Proposed Second Safety Lamp Competition.—In the mining districts a good deal of interest is taken in a proposed second safety lamp competition, and the effort of the French miners to raise £4,000 for the purpose by lottery or subscription will, states the Glasgow *Engineer*, meet with support, if it is sought from English miners. The Frenchmen aim, it should be mentioned, at conducting experiments and offering for international competition prizes of a substantial sort.

Another Fatal Accident from Electricity.—On Tuesday a man named William Moore was instantaneously killed by touching the wires of an arc electric lighting system at Messrs. Bolckow, Vaughan & Co.'s Works, Middlesborough.

Electric Locomotion in America.—An American correspondent of the *Standard* states that it has been decided to employ electric motors on the Brooklyn Bridge within 60 days, and upon the Elevated Railways within 90 days. The agents of the Daft, Edison, Siemens, Brush, and Field electric motors have organised a company, with a capital of one million, half in cash, and the balance represented by patents to be distributed among the five original companies, in proportion to their relative merits, according to the judgment of Professors Sir W. Thomson and C. R. Cross, and the Presidents of the New York Central, the Pennsylvania, and the Northern Pacific Railways. These gentlemen may even award the entire half-million to a single motor. The new company thus becomes the sole owner of everything at present known to be valuable in connection with electric locomotion. Its promoters are sanguine of being able to produce, within 90 days, a system that shall be applicable throughout the world.

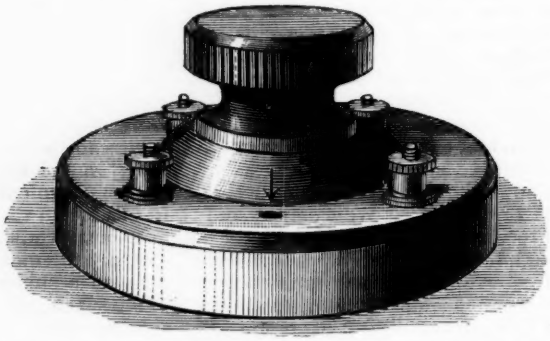
The "Pointsman" Switch.—This switch has been designed to furnish a more compact, finished, and handy current distributor for electric lighting than those hitherto in use. The working parts are all enclosed, and cannot be interfered with except by unscrewing the lid (which in the engraving is shown detached). When the lid is removed all the connections are accessible, as well as the safety fuses which are inserted in each branch wire. A strong spring to



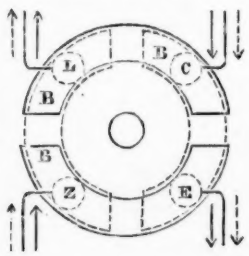
each lever admits of no intermediate stage between "full on" and "full off." The jaws, of spring metal, make contact on *both* sides of the levers. The action is very easy, a finger and thumb being sufficient to operate each lever, while the position of the handle shows at a glance whether the current is "on" or "off." Enclosed in cases of polished wood, with ivory tablets, these switches make a good appearance in any apartment, and they are made with from 2 to 20 levers. The sole manufacturers are Messrs. Faraday and Son, of London.

The Specialist's Series.—We have pleasure in announcing the issue of the first volume of a new series of handbooks for students and practical engineers, edited by Dr. Paget Higgs, and Prof. Charles Forbes. This is "Dynamo and Magneto-electric Machines," by Paget Higgs, LL.D., D.Sc., &c., &c. Further volumes by competent writers are shortly to follow, including :—"Gas Engines," by William Macgregor; "Ballooning," by G. May; "Primary Batteries," by Paget Higgs; and "Arc and Incandescent Electric Lamps," by Dr. Julius Maier. Messrs. Symons & Co., 27, Bouverie Street, E.C., are the publishers.

Harold's Current Reverser.—The accompanying illustrations represent a current reverser designed by Mr. H. C. Harold, chiefly for use in electric lighting installations, but which may of course be employed in any of the numerous applications of electricity. Current reversers innumerable have been in use for years



past, and Mr. Harold only claims the particular design herein shown. On the underneath of an insulating base are fixed four spring contact studs, the heads of which project just beyond the level of the upper surface of the base. The movable top of the instrument, which can be turned by the milled head, has, on its base, two metal slabs, which slide upon and make good rubbing contact with the studs. These studs are respectively connected from terminals to zinc, Z, copper, C, line, L, and earth, E, as shown in the diagram,



the metal slabs, B, being placed as drawn. Thus copper goes to line and zinc to earth, but by moving the milled head of the apparatus through 90° the slabs, B, assume the position shown by the dotted lines, or copper to earth and zinc to line. This current reverser presents a neat and substantial appearance, and in such a cheap form should find many users.

Underground Conductors.—The Callender Insulating and Waterproofing Company, of New York, has just secured a contract from the Long Island Telephone Company to lay part of its wires underground in the city of Brooklyn. The system adopted is that of stranding the patent insulated wires into cables of 50 (in bunches of seven), and then placing them in an iron trough and filling the whole trough up with bitumen of a special preparation. Recent experiments are said to show that the cable is largely anti-inductive, and the mode of laying it is such as to ensure freedom from mechanical injury. The main trunk line, which is to be laid in Fulton Street, Brooklyn, has 300 conductors for several hundred feet, when it branches into two conduits of each 150 conductors. The part of the city chosen for this trial is from the head telephone office, opposite the City Hall, and runs for a short distance through the busiest part of the city and terminates at a telegraph pole, there joining the present overhead system. The wire being manufactured by the Callender Company, in America, is exactly similar to that of the parent factory at Erith, and this mode of laying is identical with that adopted by the London company at the New Law Courts, Buckingham Palace, &c. Mr. John Dallas is manager of the East Newark factory, and Mr. W. W. Biddulph, also an old cable man, is superintendent of outdoor construction, while Mr. W. M. Callender is acting as managing-director.

Storage Batteries.—At the last meeting of the Engineers' Club of Philadelphia, Mr. C. Henry Roney showed a portable storage battery for mining and exploring purposes, with small incandescent lamps, illustrating his remarks with blackboard sketches. The battery shown was a modification of Plante's, devised by Dr. E. T. Starr, of Philadelphia, the electrodes consisting of V-shaped plates of sheet-lead arranged over each other, the convexity downward, with a slight interval between them, their ends attached to a lead frame by "burned" joints, the interstices between the plates being filled wtth finely divided metallic lead, exposing a large surface to oxydation and reduction when subjected to dynamic-electric or voltaic energy, and, in turn, giving off a large percentage of the "stored" energy to incandescent lamps placed in the circuit. The battery shown measured $3\frac{1}{4}$ inches long, $2\frac{3}{4}$ inches high, and $\frac{3}{4}$-inch thick, and would maintain a small 2-candle incandescent lamp at incandescence for about one hour. A battery sufficiently large to run an 8-candle lamp for ten or twelve hours would not be too large or heavy to carry conveniently for mine or other underground exploration.

Theft of Electric Light Fittings.—At Southwark Police Court, on Friday week, Henry Sporr, 39, and William Harkworth, 34, described as bricklayers, were charged with being concerned with another man not in custody in stealing about 1 cwt. of brass fittings of considerable value, the property of the Anglo-American Brush Electric Lighting Company, Limited, from the establishment, Victoria Works, Belvedere Road, Lambeth. The third man, who had absconded, held a confidential position in the company's employ, and had charge of such property as that stolen. The prisoners, in defence, said that they did not know what the basket contained. As they were going to work a man asked them to carry it, and as soon as the officer made his appearance he ran away. Mr. Bridge remanded the prisoners for a week.

Dimensions of Electric Lighting Leads.—Mr. J. S. Beeman has just compiled and published in a contemporary a very useful diagram for facilitating the determination of the proper size of any conductor for electrical purposes, but more particularly for electric lighting by incandescence. Could not Mr. Beeman bring this diagram out in the form of a cheap card, with instructions as to its use?

The General Electric Apparatus Company.—This company is circulating an illustrated catalogue of its manufactures—electric bells and medical apparatus—which, in addition to lists of prices and similar matter, gives varied information upon the application of electricity, instructions for fixing and connecting electric bells, &c.

Obituary.—The death of M. Henri Lartigue, Director of the Société Générale des Telephones, occurred at Paris on the 19th inst., at the age of 56, and after a long illness, which had left no hope of his recovery. The chief portion of M. Lartigue's career was filled with the company of the Northern Railway of France, and it was in the capacity he there occupied that he developed the ingenious and inventive qualities which led him to devise a large number of electrical apparatus applied to railway working. Among these we may mention the electric semaphore, invented by him jointly with MM. Tesse and Prudhomme, an automatic whistle, a level crossing indicator, a controlling apparatus for switches, &c. When the Société Générale des Telephones was incorporated at Paris, by the amalgamation of the several independent companies, M. Lartigue was elected its manager, and he by his tact, business qualities, and technical knowledge, contributed largely to the success of the enterprise. The death of M. Lartigue, who was a member of the Consulting Committee of French Railways, will be long felt as a loss to the scientific world.

Electrolytic Extraction of Copper.—*Engineering and Mining Journal* states that at the works at Oker, in Germany, there are in operation five machines, C_1, by Siemens and Halske, of Berlin, each machine being connected to 12 depositing baths. Each machine is driven by water-power of four to five horse-power, and deposits about 300 kilos. of copper per day. At the North German Refining Works, in Hamburg, six Gramme machines (No. 1), and one Wohlwill machine are working, precipitating 2,500 kilos. of copper per day. Hilarion Roux, at Marseilles, works with a No. 1 Gramme machine connected with 40 baths, giving 900 square metres of anode surface; the cathodes being 5 cm. from the anodes, and 0·5 mm. thick. The machine makes 850 revolutions per minute, consumes 250 kilos. of coal per day, and deposits 250 kilos. of refined copper, with 8 volts 30 ampères. It is understood that in this country the electrolytic process of working copper is coming more and more into favour, especially for argentiferous copper materials, and that recently in the Swansea neighbourhood new plants have been erected, and old ones extended. But details of the mode of working, and results obtained, have, so far, not transpired, beyond vague generalities.

Trade Mark Action.—Edwards *v.* Dennis. This action, tried on the 18th inst., before Mr. Justice Smith and a special jury, at the Liverpool Assizes, was brought by Mr. Edwards, of Birkenhead, to restrain Mr. N. F. Dennis, the London representative of Messrs. Felten and Guilleaume, of Mulheim-Cologne, Germany, manufacturers of wire, from using the Neptune brand. In the latter part of 1878, Messrs. Cromar, Scott & Co., of Liverpool, manufacturers of iron sheets and jobbing galvanisers, registered as a trade mark in class 5, a device consisting of the figure of the god Neptune, with the word "Neptune"; about 18 months since, Mr. Edwards acquired the business of Cromar, Scott & Co., including the trade mark in question. In 1880, Messrs. Felten and Guilleaume registered for steel wire and iron wire (class 5) a trade mark consisting of a trident and the word Neptune. It was elicited on cross-examination of the plaintiff and his witnesses, that neither he nor Messrs. Cromar, Scott & Co. had ever manufactured wire, but that over a period of 10 years Messrs. Cromar, Scott & Co. had galvanised small lots of wire of other manufacturers, the entire quantity of wire so galvanised not exceeding 5 to 10 tons; that they had not galvanised any wire for the last 5 years; and that Mr. Edwards for several years had been cognisant of the defendant's brand. On behalf of the defendant, evidence was given to show the enormous quantity of wire manufactured by Messrs, Felten and Guilleaume from the year 1877, and which had been advertised and sold by them under their Neptune brand. The further consideration of the action stands over until the return of Mr. Justice Smith to London, when the important questions of law will have to be argued before him.

The Société Internationale des Electriciens.—This society has decided to hold an exhibition in January, 1885, on the occasion of its first general assembly. This exhibition will comprise a collection of apparatus illustrating the discoveries and improvements made up to the present time, and a summary of the progress realised will be given by means of lectures by the most illustrious *savants* and the most eminent electricians. It will take place at the Paris Observatory, in a suite of rooms which Admiral Mouchez, manager of the observatory, has kindly placed at the disposal of the society. French and foreign electricians, whether members of the society or not, who desire to take part in the exhibition, must send in their applications, indicating the nature of the objects to be sent, before December 25th, 1884, to M. le President de la Société Internationale des Electriciens, 3, Rue Segnier, Paris. The cost of carriage and installation will be the only expenses charged to the exhibitors. Notice of the exact date for the opening and closing of the exhibition will be given later on.

Insurance and Actuarial Society of Glasgow.—Mr. J. Wyllie Guild, C.A., opened the session of this society last week with an address on "Steam, Chemistry and Electricity."

NEW COMPANIES REGISTERED.

New Telephone Company, Limited.—Capital £120,000, in £5 shares. Registered office, 39, Lombard Street. Objects: To purchase the patented inventions of Silvanus Phillips Thompson and Philip Jolin, relating to improvements in electric apparatus for the transmission and reproduction of sound. Signatories, with one share each: *Lord Thurlow, 33, Chesham Place; *Lord Sudeley, 7, Buckingham Gate; *Sir Daniel Cooper, Bart., 6, De Vere Gardens; *J. Irving Courtenay, 1, Essex Court, Temple; T. Hurley Jones, M.A., 15, Finsbury Circus; J. S. Sellon, 78, Hatton Garden; S. P. Thompson (Doctor of Science) University College, Bristol. The remuneration of the board is to be £400 per annum for the chairman, and £200 in respect of each other director; also 10 per cent. of the divisible profits remaining after payment of 10 per cent. dividend. Registered 20th inst. by Harley Jones and Julius, 15, Finsbury Circus.

Bromley (by Bow) India Rubber and Gutta Percha Company, Limited.—Capital £75,000, in £2 shares. Registered office, St. Leonard Street, Bromley-by-Bow. Objects: To take over the India rubber and gutta percha business of Master & Co., of Phipps Street, Finsbury, and Park Street, Camden Town: also to acquire the right to manufacture, erect, or lay down, on land or water, telegraph lines, telephones, phonographs, and all electrical apparatus, including wires and appliances for connecting apparatus at a distance with other electric apparatus. Signatories, with one share each: H. Steele, 21, College Hill; H. W. Howard, 98, Park Street, Camden Town; W. J. Dring, 72, Harrogate Road, N.E.; R. Cartwright, 34, Upper Street, N.; A. J. Macrone, 291, Camberwell New Road; C. B. Robins, 225, Great Dover Street, S.E. The signatories are to appoint the first directors. Remuneration, 5 per cent. of the surplus profits remaining after payment of 12 per cent. per annum dividend. Registered 21st inst. by A. R. and H. Steele, 21, College Hill, E.C.

* Signatories whose names are preceded by an asterisk are also directors.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Primary Battery Company, Limited.—Upon terms of an agreement of 22nd August (filed on the 20th inst.) this company will purchase from Messrs. Thomas John Jones, of 12, Princes Street, Hanover Square, and Desmond Gerald Fitzgerald, of 6, Akerman Road, Brixton, certain letters patent for France, Germany, and Belgium, granted for improvements in obtaining materials and elements to be used in the constructing and working of primary voltaic batteries. The consideration is £3,300 in fully paid shares.

The company will also adopt an agreement of 16th July (filed on the 20th) for the purchase of the British letters patent, No. 1121, dated 1st of March, 1883, and also No. 5417, granted in respect of the invention above referred to. The agreement cites that shares are to be allotted as follows:—

90	fully paid shares to		Mr. Jones,	equal to	£450
90	,,	,,	Mr. Wm. Minnis,	,,	£450
100	,,	,,	Mr. J. Glode Stapleton,	,,	£500
	(In consideration of £500 subscribed.)				
53	fully paid shares to		Mr. D. A. Davis	,,	£265
147	,,	,,	Mr. Fitzgerald	,,	£735
75	,,	,,	Mr. W. Arbuthnot	,,	£375
10	,,	,,	Mr. W. C. Jackson	,,	£50
35	,,	,,	Mrs. M. Duchscherer	,,	£175
					£3,000

Messrs. Jones and Stapleton are appointed managing directors.

CITY NOTES, REPORTS, MEETINGS, &c.

The Gülcher Electric Light and Power Company, Limited.

THE report of the above company to be submitted to the shareholders on December 4th, states that: In submitting the balance sheet and accounts of the Gülcher Electric Light and Power Company, Limited, for the fifteen months ending the 30th September, 1884, the directors desire to remind the shareholders of the circumstances under which the present board was appointed:—

At the first annual general meeting of the company, held on the 30th day of August, 1883, the accounts of the company from its commencement and the balance sheet on the 30th June, 1883, were presented by the original directors of the company, and, under protest, passed by a majority of the shareholders present at the meeting.

At the adjourned general meeting, held on the 28th September, 1883, the whole of the original directors having retired, an entirely new board was elected, and the business of the company has been carried on for another year from that date. During that year Prof. Crookes and Mr. Cornell retired from the board, the place of Mr. Cornell being filled up by Mr. Gilman, the late general manager of the company, who was asked to become a director. Mr. Johnson has never taken his seat at the board.

The shareholders have already been informed of the appointment by the new board of an investigation committee, the short result of whose labours was, first, that £70,000, part of the purchase money of the Gülcher patents was agreed to be surrendered and given up by the promotors to the company; and, secondly, that Messrs. Gülcher, Groth and Crookes, the real vendors to the company, voluntarily agreed—in consideration of the altered conditions of the company—to surrender a further £19,050 in fully paid-up shares.

These agreements have since been confirmed by an order of the High Court of Justice, and the capital of the company has been formally reduced to £150,000.

It is needless to state that these negotiations involved not only loss of time but also a considerable expenditure of money, which forms a part of the heavy losses which the directors have to deplore.

Particulars showing where and how the losses of the past fifteen months have been incurred will be placed before the shareholders at the approaching general meeting. Many of them are due to causes which the directors have to lament in common with the directors of other electric light companies; some of them to special causes connected with the origin and earlier management of this company, to which, however, it will be sufficient to draw attention at the above-mentioned general meeting; but there are some causes so flagrant and palpable that the directors think it right to prepare the shareholders for the announcement of them by mentioning them in this report, and by informing them of the steps which they have taken to obtain redress.

The first cause which calls for special attention is the reckless way in which the applications for allotment of shares were accepted by the original directors; the result of which is shown by the large item "calls in arrear" on the debit side of the balance sheet.

Another, and even more serious cause, was the unwise arrangement entered into by the late directors with Messrs. Ransome & Co., of Battersea. It is true that Messrs. Ransome & Co. have in a very handsome manner modified that arrangement by reducing the rent of their factory from £600 per annum as originally agreed, to £400 per annum the present rent; and they have also for a consideration which will cost the company about £900, released it from an agreement, which if it could have been carried out would have brought them in many hundreds per annum; but the fact remains that the present board has had to expend the last mentioned sum, and has had to pay this heavy rent for premises which, whether they are worth it or not in the market, are certainly not worth it to this company.

But by far the most serious cause of all was the enormous amount of the sums paid for the Gülcher and Crookes patents. The price paid for the Gülcher lamp and dynamo was originally £100,000. This has been reduced to £30,000, the greater part of which has been paid in shares of the company; but even this reduced price is a very large one, and involves the writing off every year of a very large sum which forms a large proportion of the total loss. There is this to be said, however, in favour of the Gülcher lamp and dynamo, that they are both, the lamp especially, valuable patents, and as being now manufactured are merchantable articles and are holding their own, if not something more, in the electric lighting market. Moreover, the adjuncts to these patents in the shape of the Gülcher switch table and the Gülcher "exchange switch," since given to the company by Mr. Gülcher, have attracted great attention and have done much to assist this company on several occasions.

The same cannot be said of the patent sold to the company by Prof. Crookes. The price paid for the "Crookes" incandescent lamp was originally £35,000, of which £11,700 was to be paid in cash, and £23,300 in fully paid-up shares of the company. In addition to this, and to use his own words, "as part of his purchase money," £525 per annum was to be paid to Prof. Crookes as consulting electrician, and £500 per annum to his son, Mr. Henry Crookes (for 5 years at least) for superintending the incandescent lamp department. It is true that Mr. Crookes, as above stated, voluntarily surrendered last autumn nearly half the amount of his fully paid up shares, and more lately he has retired from the post of consulting electrician; but on each occasion he has sought to bind more fast the other fetters which he had placed upon the company, and besides £1,978 paid in fees and salary to him and his son, he has received £7,700 in cash, £4,000 in bonds, and £13,050 in paid up shares in the company, as the purchase-money for his lamp, together with interest up to date upon so much of such purchase money as from time to time has remained unpaid.

It might have been that even this large price had not been excessive, but the experience of the last 12 months has led the directors to the conclusion that the invention is valueless. Every aid has been given to Mr. Henry Crookes by the board to enable him to turn out a marketable article, and to avoid the necessity of making this report; but notwithstanding that £4,065 has been spent from first to last upon the incandescent lamp department, and notwithstanding the most persevering and intelligent endeavours on Mr. Henry Crookes's part to produce a good lamp, he is unable, and never has been able, and the board see no prospect of his ever being able, to manufacture a marketable article.

As may be readily believed, the hands of the directors have been very much tied by being unable to tender with confidence for any installation involving the use of incandescent lamps. In almost all the cases in which it has sold "Crookes" lamps the company has either had to take them back, or the purchasers have refused to pay for them; so that while the directors could not reasonably recommend lamps manufactured by other makers, they dare not sell their own. This has been a source of the greatest difficulty and injury to the company.

Under the circumstances above detailed, the directors invited Professor Crookes to return to the company half his purchase-money, and to take back his patents; but this offer having been absolutely refused, the directors have, on grounds which it would be improper to disclose here, brought an action against Mr. Crookes for the return of the whole of the purchase-money, with damages for the losses the company has sustained, and they trust that the shareholders will support them in the course they have thought it their duty to pursue.

On the other hand, the success of the few installations with the Gülcher dynamos and the Gülcher arc light, which the limited means at their command have enabled the directors to undertake, has been so satisfactory that it is with the greatest regret they have come to the conclusion to which they have been compelled to come. That conclusion is, to submit to the shareholders at the approaching general meeting whether, in view of the circumstances above stated, the company should be voluntarily wound up, or whether its business as a manufacturing company should be modified or suspended for a time, until the company has recovered from the various persons against whom it has claims sufficient money to justify it in resuming more active operations, and in taking advantage of the reaction in favour of electric lighting which seems to be setting in.

The figures contained in the accompanying balance sheet and accounts are those appearing in the books of the company. The actual deficit for the twenty-nine months' trading would exceed the deficit shown in the balance sheet by £900, but as under certain circumstances the directors propose to waive £900 of the fees to which they are entitled by the Articles of Association, the profit and loss account has been debited by anticipation with £600 only in respect of fees to the new board.

In view, however, of the large amount carried down as deficit for the 15 months ending the 30th September, 1884, the directors think it only just to themselves to state that a comparatively small amount of this deficit is due to the 12 months during which they have been in office. The loss during the last 12 months on the manufacturing account is less than £650, the whole of which, and a great deal more, has been lost in the incandescent lamp department. In the arc lamp and dynamo department there has been an actual trading profit. So also with the profit and loss account. Some of the heaviest expenses appearing on the debit side of that account are due to the condition in which the company was when it was handed over to the new board 12 months ago.

Notwithstanding these drawbacks, however, and the heavy cost of the incandescent lamp department, the actual cash loss for the last 12 months has scarcely exceeded £3,500, and the greater part of this loss will be found to have been incurred during the first six months of the present management.

Details of every item in the accounts will be forthcoming at the approaching general meeting.

With a reasonable capital and a still further reduction of its standing expenses, and by ceasing to manufacture the "Crookes" incandescent lamp, the directors are confident that a good future would lie before the "Gülcher Electric Light and Power Company, Limited;" but under present conditions they do not feel justified in continuing the struggle for existence which they have maintained for the last 12 months, without the special assent of the shareholders.

In accordance with the Articles at least two of the present directors should now retire, but under the circumstances above detailed the whole board desires to tender its resignation and place the affairs of the company once more in the hands of the shareholders.

The auditors, Messrs. William Edwards, Jackson, and Browning, and Messrs. Leslie, Kirby, Straith & Co., also retire.

Memorandum.—Since the above report was printed, the directors having, under the circumstances above detailed, refused to pay Mr. Crookes the interest due upon the debentures held by him, he has applied to the Chancery Division of the High Court of Justice for a receiver and manager of the business of the company.

LATEST QUOTATIONS.

Authorised Issue.	Share.	Name.	Paid.	Closing Quotation, Nov. 27.	Business Done.
		ELECTRIC LIGHT.			
40,000	£	Anglo-American Brush Co.	£	1½ - 1⅝	
		Do. Do.	£5	3 - 3½	
30,000	5	Australasian E. L., Power & Storage Co.	4	..	
24,000	10	British Insulite Co., Ld., "A" Shares..	6	..	
25,000	5	Gt. Western Electric Light & Power Co.	2½	⅛ - ¼	
47,233	5	Hammond Elec. Lt. & Power Sply. Co.	5	½ - 1	
40,000	5	Indian & Ori. Electl. Storage Wks. Co.	2½	..	
250,000	¼	Maxim-Weston Elec. Lt. & Power Co.	¼	1/16 - 1/16	
40,000	5	Pilsen-Joel & Gen. Elec. Lt. Co.	3½	..	
20,000	5	S. African Brush Elec. Lt. & Power Co.	2½	..	
100,000	5	Swan United Electric Light Co., Ld.	5	..	
		TELEGRAPHS.			
1,892,480*l.*	Stk.	Anglo-American, Limited	100	34½ - 35¼	
2,553,760*l.*	Stk.	Do. Pref. } Def. receiving no div. until	100	59½ - 60½	60¼
2,553,780*l.*	Stk.	Do. Def. } 6 p. c. paid to Pref.	100	9 - 10	
130,000	10	Brazilian Submarine, Limited	10	11 - 11½	
150,000*l.*	100	Do. 5 per cent. Bonds	100	102 -104	
16,000	10	Cuba, Limited	10	11 - 11½	
6,000	10	Do. 10 per cent. Preference	10	17 - 18	
13,000	10	Direct Spanish, Limited	9	3½ - 4	
6,000	10	Do. 10 per cent. Preference	10	15 - 15½	
65,000	20	Direct United States Cable, Ld., 1877	20	10 - 10½	
100,000*l.*	100	Do. 6 per cent. Deb., repayable 1884	100	..	
380,000	10	Eastern, Limited	10	11½ - 11¾	11¾
70,000	10	Do. 6 per cent. Preference	10	15¾ - 16¼	
200,000*l.*	100	Do. 5 do. Debs., repayable Aug. 1887	100	101 -104	
200,000*l.*	100	Do. 5 do. do. Aug. 1899	100	104 -107	
500,000	Stk.	Do. 4 do. Debenture Stock	100	97 - 99	99
250,000	10	Eastern Exten., Australasia & China, L.	10	12 - 12¼	
320,000*l.*	100	Do. 6 p. c. Debs., repayable Feb. 1891	100	109 - 112	
640,000*l.*	100	Do. 5 p. c. (Aus. Gov. Sub.) Deb. 1900	100	103 - 106	
100,000*l.*	100	Do. 5 per cent. Debenture, 1890	100	101 - 103	
550,000*l.*	100	{ Eastern & South African, Ld., 5 p. c. } Mort. Deb. Rg. redeemable 1 Jan. 1900	100	103 - 105	
22,050	10	German Union Telegraph & Trust, Ld.	10	9½ - 10¼	
250,000	10	Globe Telegraph & Trust, Ld.	10	7¼ - 7½	
250,000	10	Do. 6 per cent. Preference	10	12½ - 12⅞	
150,000	10	Great Northern	10	14⅜ - 14⅝	
100,000*l.*	100	Do. 5 per cent. Debentures	100	102 -105	
300,000*l.*	100	Do. 5 per cent. Debentures	100	104 -107	
81,200	10	India-Rubber, Gutta-Percha, & Tel. Wks.	10	22½ - 23½	
100,000	100	Do. 6 per cent. Debs., 1888	100	101 -103	
18,000	25	Indo-European, Limited	25	32 - 33	
40,000	10	London Platino-Brazilian, Limited	10	3¾ - 4	
100,000	100	Do. 6 per cent. Debentures	100	101 -103	
10,000	8	Reuter's, Limited	8	7½ - 8	
338,225*l.*	Stk.	Submarine	100	175 -180	
75,000	1	Do. Scrip	1	1⅛ - 1⅛	
4,200	Cert.	Submarine Cables Trust	100	103 -106	
37,350	12	Telegraph Construction and Mainten.	12	34 - 35	34½
150,000	100	Do. 6 per cent. Bonds, 1889	100	107 -109	
186,750	5	Do. 2nd Bonus Trust Cert.	2½	1½ - 1⅝	
30,000	10	West Coast of America, Limited	10	5½ - 6	
150,000*l.*	100	Do. 8 per cent. Debs.	100	113 -116	
45,181	15	Western and Brazilian, Limited	15	7⅛ - 7⅜	
24,729	7½	Do. Preferred	7½	5 - 5¼	
24,729	7½	Do. Deferred	7½	1⅝ - 2⅛	
280,000*l.*	100	Do. 6 p. c.. Debs. "A" 1910	100	104 -106	
250,000*l.*	100	Do. 6 p. c. Mort. Deb. B. '80, red. Feb. 1910	100	98 -100	
1,500	$1,000	Western Union 7 p. c. 1 Mort. (Bg.) Bds.	$1,000	120 -122	
1,030,000*l.*	100	Do. 6 per cent. Sterling Bonds	100	100 -103	
88,321	10	West India and Panama, Limited	10	¾ - 1	
34,563	10	Do. 6 per cent. 1st Preference	10	7½ - 7⅞	
4,669	10	Do. 6 do. 2nd do.	10	4½ - 5½	
		TELEPHONES.			
224,850	1	Con. Tele. & Mainten., L., Nos. to 154,165	1	1/16 - 1/16	
225,000	1	Oriental Tele. Co., Nos. 80,001 to 300,000	¼	⅛ - ⅜	
100,000	5	United Telephone Co.	5	11½ - 11¾	
20,000	5	Do. New, issued at £2 pm.	2	6 - 6½	

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 21st, were £3,789; after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

NEW PATENTS—1884.

15233. "Effecting transmission of electric energy to torpedoes, mines, &c." L. GOLDBERG, A. L. FYFE. Dated November 19.

15239. "Dynamo-electric and magneto-electric machines." E. J. M. DAVIES. Dated November 19.

15253. "Galvanic batteries." W. H. AKESTER, R. R. KELLY. Dated November 19.

15273. "Incandescence electric lamps." F. WYNNE. Dated November 20.

15318. "Contact devices for electrical apparatus." W. R. LAKE. (Communicated by C. F. de Redon.) Dated May 27.

15331. "Electrical machines known as electro-static inductive generators." C. L. CLARKE, H. J. COATES. Dated November 21.

15351. "Destroying induction in electric wires." J. HART DAVIES. (Communicated by K. Dembinski.) Dated November 21.

15355. "Electric locomotives or electro-motor engines." F. H. DANCHELL. Dated November 21. (*Complete.*)

15357. "Suppressing induction in telegraph and telephone lines." J. C. MEWBURN. (Communicated by M. Deprez and C. Herz.) Dated November 21.

15365. "Apparatus for electro-plating and applicable for treating metallic surfaces by electrolysis." H. J. Haddan. (Communicated by G. Wagner and C. Netto.) Dated November 21.

15371. "Voltaic batteries." D. G. FITZGERALD, T. J. JONES. Dated November 21.

15372. "Electric cables." H. H. LAKE. (Communicated by J. Greenalgh and P. Chase.) Dated November 21. (*Complete.*)

15392. "Electric street fire alarms." J. ROBERTS. Dated November 22.

15399. "Electrical conductors." E. FOX. Dated November 22.

15439. "Apparatus applicable to telephony and telegraphy." J. STEPHEN. Dated November 24.

15453. "Compound galvanic batteries, and method of working same." S. H. EMMENS, United Patents Corporation. Dated November 24.

15476. "Electric arc lamps, having reference to the candles or carbons." J. H. SELWYN. Dated November 24.

15480. "Membrane telephones." S. P. THOMPSON, P. JOLIN. Dated November 25.

15500. "Clocks and apparatus for actuating or controlling the same by electricity." W. P. THOMPSON. (Communicated by C. H. Pond.) Dated November 25. (*Complete.*)

15523. "Connecting the stranded wires used as stays for telegraph posts, &c." H. C. JOBSON. Dated November 25.

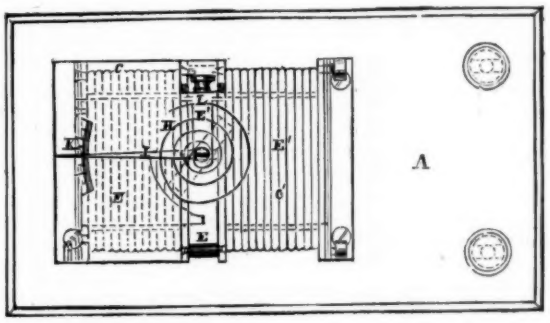
15524. "Clutch for electric arc lamps." J. BROCKIE, M. W. W. MACKIE. Dated November 25.

15544. "Electricity gauges." J. and H. M. GOODMAN. Dated November 25.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

9969. "Improvements in anti-magnetic shields for watches." C. K. GILES. Dated July 9. 4d. The object of this invention is to completely protect the watch from the deleterious influence of magnets, so that it may be carried into the presence of dynamo machines or into the presence of magnets elsewhere with perfect security against injury; and to shield the watch from the magnetism and magnetic currents of the body. This result is accomplished by surrounding the works of the watch with a complete shield of highly magnetic metal, or an alloy or combination of metals, which, in common language, may be said to absorb or turn aside the magnetic currents, thereby preventing their reaching the watch movement.

10366. "An electric meter." R. E. DUNSTON. Dated July 19. 4d. The fig. is a plan of the invention. On a base, A, of insulating material is fixed a double solenoid consisting of two coils, c c^1, of insulated wire wound on a tubular casing of rectangular section. Within these coils are soft iron cores, E, E^1, having their inner ends shaped as shown, with a projecting tongue at one side and the rest of the end curved and sloped away therefrom. In the middle, between the coils, is pivotted on a bracket a vertical spindle, having fixed on it a soft iron armature, G, one end of a volute spring, H, and a light index, I, pointing to a graduated scale, K. The outer end of the spring, H, is clamped by a screw



at L, by loosening which the end of the spring can be drawn to such a position as to bring the index, I, to zero of the scale, K, when no electricity passes through the coils, c, c^1. The spring being clamped in this position, on sending an electrical current through the coils, c, c^1, the action on the armature, G, is such as to deflect it to an extent shown by the index, I, depending on the character and amount of the electrical current. The coils, c, c^1, may be of large wire offering little resistance or of small wire offering great resistance, according as the meter is employed for measuring intensity or electromotive force.

11115. "Improved means for connecting the carbon filaments of incandescent electric lamps to their conducting wires." C. D. ABEL. (Communicated from abroad by the firm of Messrs. Siemens and Halske, of Berlin.) Dated August 9. 2d. According to the present invention the connections between the carbon filament of an incandescent electric lamp and the platinum conducting wires passing through the glass bulb are made as follows: The ends of the platinum wires are hammered flat and are helically coiled round the ends of the carbon filament. These coils are then electrolytically coated with copper, so as to establish a firm connection between them and the carbon filament, leaving however the extreme ends of the coils, which are in direct contact with the incandescent filament without such coating.

CORRESPONDENCE.

The Life of Incandescence Lamps.

Permit me to call your attention to the following extract from an article entitled "Incandescence Lamp Patents," which appeared in your issue of 22nd inst., page 402.

"Only about three weeks ago Mr. Trotter showed very clearly that it would be cheaper in the end to employ lamps of high electrical economy, even if their lives were shorter than those of a type with a lower electrical economy and a longer existence."

I am afraid that this will be interpreted by some of your readers as meaning that Mr. Trotter has shown that with lamps and power at their present relative prices, short lives of lamps should be preferred; whereas all that Mr. Trotter did was to show that where lamps were dear and power cheap, it would be better to use lamps with a low electrical efficiency and long life, and *vice versa*.

The following extract from Mr. Trotter's letter puts the case very clearly :—

"In short, if the lamp is very expensive, say 7s. 6d., and power may be had for a mere nothing, all our attention must be devoted to prolonging the life, the efficiency being nugatory; but if we could get lamps at a fair and reasonable price, say 9d., and were forced to use some extravagantly expensive source of power, such as a primary battery, we should strive to attain a high efficiency, the life being only a question of the trouble of replacing the dead lamps."

"Je vois."

November 26th, 1884.

[Lamps are being gradually reduced in price and may, we understand, be now obtained with a life of 1,000 hours and a consumption of 2½ watts per candle-power, at one-third the price first quoted by our correspondent.—EDS. ELEC. REV.]

The Iron Disc in Bell's Telephone, and its Equivalents.

May I be permitted to ask you, Messrs. Editors, or any of your readers to reply to the following questions:

1. In a telephone is a stretched membrane, having a piece of iron attached to its centre, an equivalent for the steel plate as used in the Bell instrument?
2. If it be an equivalent, as it is free to the public, is the steel plate also free?
3. If it be not an equivalent wherein does it differ from the steel plate?
4. Is the use of any equivalent of any part claimed in a patent an infringement of the patent?
5. Is the use of any equivalent of any part originally claimed, but afterwards expressly disclaimed, in consequence of prior publication, an infringement of the patent as disclaimed?
6. In a telephone is the armature fastened loosely by one extremity to a fixed support, and its other extremity attached to the centre of a stretched membrane in front of a magnet, an equivalent for the steel plate of the Bell telephone? Questions 2, 3, 4, and 5 will also apply to this device.
7. Is a disc of wood or cardboard or vulcanite, having a piece of iron attached to its centre, to be used in a telephone, an equivalent of the stretched membrane with the iron attached to its centre?
8. Is a disc of wood or cardboard or vulcanite, having a piece of iron attached to its centre, to be used in a telephone, an equivalent of the steel plate of the Bell telephone?
9. Is a disc of wood or cardboard or vulcanite, with an armature fastened loosely at one extremity, and its other end attached to the disc, an equivalent of the membrane with such an armature, or is it an equivalent of the steel plate used in the Bell telephone?
10. Do the words "*equivalent plate*," which were substituted in the disclaimer for the word "*material*" of the original patent include more than can be included by the word "*material*"?

The sentence in the original patent was: "This invention is not limited, however, to the use of a steel plate, but includes within its scope any *material* capable of inductive action upon a current of electricity"—and the claim is: "The combination of an electro-magnet with a plate of iron or steel, or other material capable of inductive action."

The patentee in his amended specifications describes the action of the membrane telephone to be identical with that of the steel plate telephone; but he says, "a plate of thin steel, instead of the cone membrane and armature, may with greatly increased advantages be used." Now the effects produced by the two plates being identical, I am desirous to be informed on the above questions, and I hope some of your scientific readers will enlighten me.

W. C. Barney.

November 25th, 1884.

[Perhaps Mr. Barney will find a satisfactory, but unintended, reply to certain of his queries in the letter of F. T. H.—EDS. ELEC. REV.]

Bell's Telephones.

Your correspondent "F. T. H." can find "The Report on Awards, Group xxv., Centennial Exhibition, Phil. U. S., 1876, by Sir W. Thomson and Joseph Henry," at the office of the United States Minister, Members' Mansions, Victoria Street, S.W.; also at the office of the U. S. Consul-General, No. 11, Abchurch Lane, E.C., and probably in many public libraries: and he can procure a copy from the United States by application to the U. S. Consul-General.

Your correspondent will find on page 297 of the REVIEW of October 11th, 1884, the statement that Bell's apparatus, exhibited and tried by Sir W. Thomson, was described in the *Scientific American*, a journal largely circulated in this country, of September 9th, 1876, vol xxxv., page 162, on public view in the British Patent Office in October, 1876, and there at present. He can also find in the Patent Office the same description in the *Journal of the Telegraph*, published in New York, October 16th, 1876, page 312, and in *The Telegrapher*, also published in New York, August 1st, page 227, 1876—both prior to Bell's application for his patent. Bell's address, delivered on May 10th, 1876, before the American Academy of Arts and Sciences, published in the "Proceedings" of that Academy, can be found in the library of the Royal Society, and perhaps of other scientific societies.

The description in these publications is as follows :—"Two single-pole electro-magnets, each having a resistance of 10 ohms, were arranged upon a circuit with a battery of five carbon elements. Drumheads of gold-beater's skin, seven centimetres in diameter, were placed in front of each electro-magnet, and a circular piece of clock spring, one centimetre in diameter, was glued to the middle of each membrane."

This instrument is what is known as the English Mechanic, because of the *English Mechanic* having been the English paper which first published it.

The instrument which was disclaimed by Morgan Brown (Bell) on 13th February, 1878, is described and represented by drawings in Bell's United States Patent of February 14th, 1876, which described an instrument to be used as a transmitter and receiver, viz., "one end of an armature attached to the centre of a stretched membrane," was published in England on 3rd July, 1876—in the U. S. Official Gazette of Patents, dated 7th March, 1876.

Common Sense.

November 23rd, 1884.

On Secondary Batteries.

Mr. Preece's paper in your last issue is of very great interest, and there is one point about which I should like information. The paper gives a comparison of secondary batteries with dynamos and primary batteries. A comparison is also made among secondary

batteries themselves, though the data are not quite explicit enough. I notice that the charging current for Mr. Tribe's cells was $3 \times 48 = 144$ ampère hours; while the F.S.V. cells must have taken over 300 ampère hours. This would appear to indicate a considerable difference in sizes in favour of Mr. Tribe's cells. I should like to ask if this presumption is correct, or if not, what were the relative sizes?

Inquirer.

November 23rd, 1884.

The Theory of Alternating Currents, &c.

As you have done me the honour of publishing a *resumé* of my paper read before the Society of Telegraph Engineers, will you favour me by giving equal publicity to the enclosed note which I am adding to that paper?

J. S. Hopkinson.

4, Westminster Chambers,
Victoria Street, S.W.,
November 22nd, 1884.

Note added 22nd November, 1884.

My attention has only to-day been called to a paper by Mr. Wilde, published by the Literary and Philosophical Society of Manchester, December 15th, 1868; also *Philosophical Magazine*, January, 1869. Mr. Wilde fully describes observations of the synchronising control between two or more alternate current machines connected together. I am sorry I did not know of his observations when I lectured before the Institution of Civil Engineers, that I might have given him the honour which was his due. If his paper had been known to those who have lately been working to produce large alternate current machines, it would have saved them both labour and money.

[The paper to which Dr. Hopkinson alludes will be found in our other columns.—EDS. ELEC. REV.]

Siemens's Relay.

Will you be so good as to inform me, through the columns of the ELECTRICAL REVIEW, whether the action of Siemens's relay, when a current enters the coils, is correctly described at page 62 of Preece and Sivewright's "Telegraphy?" Fig. 39, page 61, shows the coils to be wound left handed, and a current entering at terminal 5, as stated, would therefore, it appears to me, instead of completing the local circuit, increase the N polarity of P, decreasing that of P^1, and make the tongue, C, press harder against the insulating point, D^1.

I altered my copy of the 1st edition as follows; but as I find the original description is unchanged in the latest edition, I should like to know whether I am right or wrong.

"As soon, however, as the line current enters the coils from terminal 6, P, P^1, becomes an electro-magnet, while N pole is p^1, and S pole p; the pre-existing north polar magnetism of p^1 is consequently very much increased; that of p is, on the other hand, greatly diminished, and, if the line current has been of sufficient strength, is entirely neutralised or even reversed," &c.

S.

Glasgow, *November 20th*, 1884.

[Our correspondent is right.—EDS. ELEC. REV.]

Self-regulating Machines.

Would you allow me to correct, through your widely-circulated paper, an error appearing in the last issue of a contemporary journal affecting the exact chronology of the invention in question? As it may form an interesting page in the history of scientific discoveries, perhaps you will afford me a short space for the purpose of putting the matter right.

The error alluded to is found in the following passage:—"The invention of compound-winding has been claimed for others, but it remains a fact *that the first dynamo machines made practically self-regulating by the compound principle were those made and set to work by Messrs. Crompton for Mr. Cooper, at Berechurch Hall, near Colchester, in the spring of* 1882." I put the passage in italics so as better to draw attention, by the context, to the utter fallacy of the statement. The first dynamo applied *practically to work* on the compound-wound principle was by Dr. Paget Higgs, at Greenpoint, Long Island, in 1881. It was a Wood's dynamo, made by the Fuller Company, and by the instructions of Dr. Higgs; the series coils on one side of the machine were replaced by fine wire shunt coils. This machine was subsequently removed to the corner of Chestnut Street and Seventh Street, Philadelphia, by Mr. Russell A. Bellew, the well-known financial agent of Boston, and was there exhibited *publicly*, as well as before Governor Harbranft and the Honourable Mr. Moore, of that city. This machine was driven by a Colt's 6-H.P. disc engine, running at 900 revolutions, steam being got from a 10-H.P. Baxter boiler. Maxim's incandescent lamps were used. Moreover, the machine had been previously shown to Professor Trowbridge, of Harvard College, and the compound principle of winding explained to that scientist by Dr. Higgs at the Fifth Avenue Hotel, New York.

Four Gramme machines were compound-wound under Dr. Higgs's instruction as early as April, 1881, in New York, and are still at work.

In November, 1881, this *gentleman shipped to me in Liverpool, to my order, two compound machines wholly made by him, one of which is still in my possession, in good working order.*

In fact, as early as May, 1880, Dr. Higgs was constructing self-regulating machines of an experimental character in Boston, and his first application for letters patent for such is clearly shown by the commissioner's receipt, now before me, dated *22nd April*, 1880. His patents for them, subsequently applied for and granted, bears the date of *April and May*, 1881.

I repeat, again, that self-regulating compound-wound machines were in this country on view in November, 1881, within my own personal knowledge; and I may add, moreover, that as early as December, 1881, a compound machine, wound to give a constant current, was built under Dr. Higgs's instructions, and employed in America for arc lighting, an application that has never, to my knowledge, been attempted by any one else. It ought to be remembered, to the credit of Dr. Higgs, that he is not a manufacturer like Mr. Crompton, to whom the writer of the erroneous statement in question is so desirous of presenting the patent for self-regulating machines.

Such, however, is the spirit of appropriation, now-a-days, that the toil of an inventor does not, by any means, end with his invention; it is only beginning with the incessant labour of defending it.

W. MacGregor.

22, Marmaduke Street, Liverpool.

The "Bell" and "Edison" Patents.

I am obliged to "Common Sense" for that portion of his letter which I take it (as one of the "birds") was "fired" at me; I think in using his double shot my share was only a "blank" cartridge.

In the first place, "Common Sense" dissents from my opinion "that the Hughes microphone requires no diaphragm," because (as I take it) he says "it always *was* attached to a diaphragm." Questions of fact on one side, this seems to me rather a peculiar argument; I simply said that it *requires* none, not that it *had* none, when shown by Hughes. But is he quite clear that the Hughes microphone had a diaphragm? I think not. I have not the address of Prof. Hughes to the Royal Society before me at this moment, but I see Mr. Justice Fry, in delivering judgment, speaks of Prof. Hughes discovering, in 1878, that the sound

waves produced by the voice might be made to operate "without the intervention of any diaphragm or tympan." However that may be, when I used the term "Hughes microphone," I merely meant the pencils and the blocks in which they rest, and this is, as I understand it, the "Hughes microphone," whether used with a diaphragm or not.

As to my statement that "we may therefore use a carbon tension regulator, and we may use a resonant case," I can only think that either your correspondent has misunderstood Mr. Justice Fry's decision, or he has misunderstood me. In the first place, Mr. Justice Fry never had the question of a resonant case before him; and, moreover, he never said that a resonant case and a tension regulator would be an infringement. Neither Mr. Justice Fry's judgment nor Edison's patent prohibits the combination of a resonant case and a tension regulator, so long as there is no diaphragm to intercept the sound waves from the carbon tension regulator. The resonant case and the tension regulator are disclaimed, and they are not claimed in *combination*; in fact, the patent distinctly states that he claims no part except what he mentions in the claim—the *combination* of the diaphragm and the tension regulator. Now, what does Mr. Justice Fry say? "It is to be borne in mind that in construing claims one must construe them not as enlarging the operation of the description, but rather as disclaiming everything which is not claimed." I am sure, however, that "Common Sense" is confounding the terms resonant case and diaphragm. Let us call the resonant case or box, A, the diaphragm or tympan, B, and the tension regulator, C. Let us take away B and C, and fix in any suitable manner one or more carbon pencils in the usual primary circuit. Now, does "Common Sense" understand what I mean by "we may therefore use a carbon tension regulator, and we may use a resonant case"?

What does your correspondent mean by "the buzzing sound in the Bell receiver"? Does he attribute some "buzzing" sound to any inherent defect in the instrument itself? If he does, I think he is wrong. I have often heard such "buzzing," both in Bell's and other receivers, but it has always been due either to induction from neighbouring wires or the transmitter.

With regard to my being in error when I state that "Bell (Morgan Brown) disclaims a tympan (a membrane) not capable (of itself) of inductive action," I can only imagine that "Common Sense" has never seen or heard of Bell's disclaimer, or again misunderstands me; the latter, I think, because the sentence is as clear as can be. Moreover, he says himself (perhaps unconscious that I mean the same thing), that "Bell disclaimed the use of a membrane like goldbeater's skin." His charge of error here is therefore self confuted.

Now, as to the broader question of *any* tympan not capable of itself of inductive action, I do not forget, sir, that you have on one occasion pointed out the difference between "induction" and "inductive action," and I have well in my mind the difference. In the Bell disclaimer, after describing the steel plate (and mind, an iron plate is not mentioned specifically until we come to the claims), the patent goes on to say that it is not confined to a *steel* plate but to any *material* capable of inductive action upon a current of electricity. But the disclaimer has struck out the word "material" and inserted "equivalent plate." This, however, makes no difference, because the fourth and fifth plans are preceded by the statement that no claim is made to anything other than is set forth in the claiming clauses "hereunto annexed." Now, the essence of the claims is the combination in the manner described of "a plate of iron or steel or other *material* capable of inductive action" with an electro or permanent magnet. Understand, it is not here "iron or steel *or other equivalent plate*" capable of inductive action; but "iron or steel or other *material*" capable of inductive action; that is, any other inductive substance. We know that iron or steel is not the only inductive substance, although it is the best, and therefore the patent claims, as it has the right, any or all plates of inductive substance, made, and in combination, in the manner described in the fourth and fifth plans. If the patent claimed a non-inductive plate, it should read "a plate of iron or steel or other *material not* capable of inductive action." In my humble opinion, the patent is as clear as it can possibly be upon that point, without any judicial interpretation; but, fortunately, we have Mr. Justice Fry's definition of the very thing itself. It had been urged against the patent that it sought to cover an equivalent plate capable of inductive action. Mr. Justice Fry, however, thought the patent was sufficiently definite. He says "the description of the subject matter of the plate is adequate; *the plate described must be inductive*, and equivalent to a steel plate as regards its capacity to vibrate with the voice. When these qualities are found, it seems to come within the description contained in the amended specification." Surely, sir, there is nothing ambiguous about this? Nothing short of bigotry or wilful misunderstanding can alter the meaning of this definition. It is not a question of a plate having a certain action, indirectly caused by induction—"*the plate described must be inductive*." I think I may safely say I have made out such a case as may go to the "jury," composed of your readers, and that I may fairly rely, if not on their verdict, at least on their favourable criticism.

In this communication I should like "Common Sense" to understand I have gone a step further than in my previous letter; I did not in that letter say a *plate* tympan. To have proved, therefore, that I did not "err," I should simply have pointed out the Reis receiver, the "English Mechanic" receiver, and the disclaimed receiver shown in fig. 19 of the Morgan Brown patent. Those instruments completely justify my previous statement, whether I have proved, on this occasion, the *plate* tympan or not.

In conclusion, I should like to express the hope that this correspondence may be conducted in a spirit of impartial and honest criticism, with the sole view of correctly interpreting the scope of the Bell and Edison patents, without hoisting particular "wares" to the notice of your readers and the public generally.

F. T. H.

Derby, *November 24th*, 1884.

Galvanometer Constants.

"A Foreign Member of S. T. E." should first place his delicate Thomson's astatic galvanometer in circuit with a high resistance and a single cell, and note to which side the mirror is deflected with, say, the positive pole of the cell attached to the right hand terminal of his galvanometer, then lower the suspension, and gently jam the damping vane with a small piece of paper to that side to which it is turned by the current; now place the galvanometer in the fourth side of the Wheatstone bridge, taking care to pass the current from his battery (which may be 10, 20, or even more cells for a high resistance galvanometer of say 6,000 ohms) in *the same direction as before*; he will find that he can very easily obtain the resistance of his galvanometer with even a common lineman's horizontal detector, or other unsensitive galvanometer. The current so passed will tend to still further magnetise the magnets of his galvanometer with the same polarity as before, and consequently rather improve them than otherwise.

Our thanks are due to your correspondent for drawing attention to the omission of a practical rule for finding the resistance of galvanometers, and we shall take care to have one inserted into the third edition of the "Pocket-book of Electrical Rules and Tables." If more gentlemen would kindly point out deficiencies or mistakes it would enable us to still further perfect the book, which we are anxious to do.

Munro and Jamieson.

College of Science and Arts, Glasgow,
November 24th, 1884.

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TIMES of *August 18th*.—"The lamps as finally adopted were the Woodhouse & Rawson Glow Lamps of 50 candle-power each, and these were variously arranged for the purpose of comparison as to the best method of suspension and light distribution. Some of them were placed singly and also in small clusters on poles 20 feet high, while others were suspended singly from cantilevers over the pathways and at a less height. Others, again, were suspended at a height of 20 feet above the centre of the roadway, and 100 feet apart. A current of 2 ampères was supplied to each Lamp, which takes 52 volts and 2 ampères, which equals 104 watts, and gives an efficiency of 2 *watts per candle*. This, it will be seen, is a very high efficiency, that of the Swan Lamp being stated to be 3½ watts, and that of the Edison Lamp 4 watts per candle. It is noteworthy, too, that no breakage of the Lamps adopted occurred during the trials."

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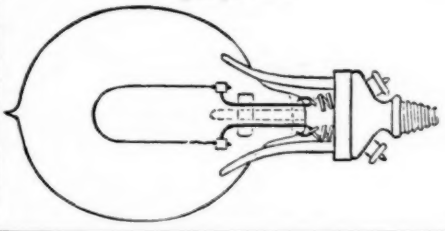

WORKS—CADBY HALL WORKS, HAMMERSMITH.

DAILY NEWS of *April 11th* on the Wimbledon Comparative Tests.—"The night before last some experiments were made with the Woodhouse & Rawson Lamps, which were regarded as very successful, and indicated an amount of efficiency that was astonishing. This enterprising firm have recently made great strides in the improvement of Incandescent Lamps."

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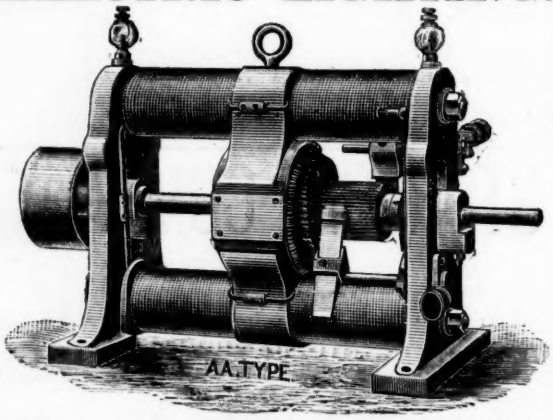

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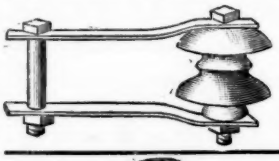

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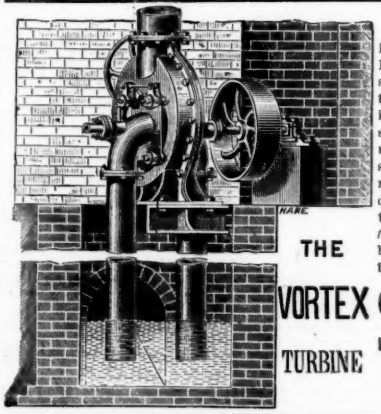

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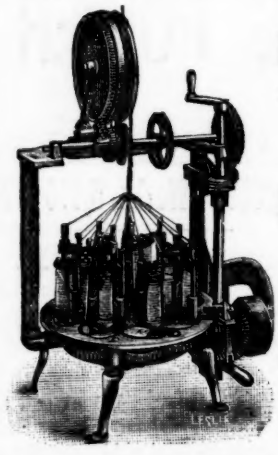

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